THE ENGINEERING RECORD

PUBLISHED WEEKLY BY THE

McGraw Publishing Company

James H. McGraw, Pres.; Curtis E. Whittlesey, Sec. and Treas.

MAIN OFFICES:
114 LIBERTY STREET, NEW YORK.

BRANCH OFFICES:
CHICAGO: Old Colony Building.
PHILADELPHIA: Real Estate Trust Building.
CLEVELAND: Schofield Building.
SAN FRANCISCO: Atlas Building.
LONDON OFFICE: Hastings House, Norfolk St., Strand.

SUBSCRIPTION RATES.

United States, Cuba and Mexico..........$3.00 a year
Canada ....$4.50 a year
Foreign subscription ....$6.00 a year
25 shillings 25 marks. 31 francs.

Foreign subscriptions may be sent to our London office.

NOTICE TO ADVERTISERS.

Changes in advertisements intended for a particular issue should reach the office of THE ENGINEERING RECORD on Friday of the previous week. New advertisements can be received up to noon of Wednesday of the week of issue.

NOTICE TO SUBSCRIBERS.

REMITTANCES.—Remittances should be made by check, New York draft, or money order, in favor of THE ENGINEERING RECORD.

CHANGES OF ADDRESS.—The old address should be given as well as the new, and notice should be received a week in advance of the desired change.

BACK COPIES.—No copies of issues prior to July, 1905, are kept on sale, except in bound volumes.

DATE ON WRAPPER indicates the month at the end of which subscription expires. The sending of remittances for renewal prior to that date will be much appreciated by the publishers.

CLUB RATE.—In acknowledgment of assistance rendered by subscribers in the securing of new orders, a club rate of $2.50 per annum is quoted. This rate applies to subscriptions in clubs of two or more, at least half of the names in the club to be those of new subscribers.

Entered at the New York Post-Office as Second Class mail matter.

Copyright, 1907, by the McGraw Publishing Co.

Of this issue of THE ENGINEERING RECORD 14,250 copies are printed. Total circulation for 1907 to date 406,250 copies, an average of 14,509 copies per week.

TABLE OF LEADING ARTICLES.

Ethics, Law and Business Rules.................. 29
The Contracts for the Ashokan Dam............ 30
Promoting 30
Unit Bids in Machine Installations............. 30
The Fortieth St. Track Elevation of the Chicago Junction Ry. (Illustrated)...................... 32
The Quebec Bridge Superstructure Details—III. (Illustrated) 35
A Gravity Water Supply at Montrose, Colo........ 37
An Official Examination of the Battery Tunnel, New York 38
Difficult Cofferdam Work on Decomposed Rocks... 39
The Big Cottonwood Conduit of the Salt Lake City Water Supply 39
Heavy Columns in the Metropolitan Tower, New York. (Illustrated) 40
Heating and Ventilating the Hotel Knickerbocker, New York City. (Illustrated) 41
A Novel Moist Chamber. (Illustrated)........... 44
The Hydro-Electric Plant of the Vancouver Power Co. 45
Sinking Shaft Through Quicksand by the Pneumatic Process. (Illustrated).................. 46
The Engineer as a Professional Man.............. 48
Strength of Red and Yellow Douglas Fir Bridge Stringers 49
Proposed Code of Ethics for Electrical Engineers.. 49
Large Riveted-Steel Sewers in Jersey City, N. J. (Illustrated) 50
Some Effects of the Recent Earthquake in Jamaica Upon Railway Structures...................... 51
Erection of a Short Bridge by Long Span Methods. 52
The Construction of the Seligman Building, New York. (Illustrated) 52
The Supervision of Construction of the New York State Highways 54
Book Notes 55
An Unusual Bridge Wreck. (Illustrated).......... 56
Uniform Contracts for Government Work......... 56

Ethics, Law and Business Rules.

For a good many years the subject of engineering ethics has been discussed at meetings of technical societies. Until recently nothing came of this discussion, but a year ago the American Institute of Electrical Engineers turned over to a committee consisting of Dr. S. S. Wheeler, chairman; Dr. C. P. Steinmetz and Mr. H. W. Buck, the task of formulating such a code. At the recent convention of the Institute at Niagara Falls the committee reported a set of principles of professional conduct for the guidance of the electrical engineer, which is reprinted elsewhere in this issue. The committee reached the conclusion that it was impracticable at present to formulate an ethical code covering explicitly all the conditions which the electrical engineer may meet in his work, although it believed it to be desirable to record some of the principles which should be a guide, leaving it to him to make specific applications to his own work. The code was discussed at some length at the convention, but on account of constitutional limitations prohibiting any decisive action of a business nature affecting the Institute at a meeting for professional discussions of papers, no final decision regarding the report was reached. As the first attempt by a committee of a national engineering society to establish an ethical standard for its members, the report deserves a great deal of study.

In the first five paragraphs the code discusses certain general principles. It will be noticed, however, that there is no sharp line drawn between professional and business relations in this "general" section, although there is a fundamental distinction between the two. It goes without saying that whether a man be a consulting engineer or an employee on a salary, his relations with those about him may very properly be governed by the Golden Rule. Most people are content to acknowledge that that rule has never been equalled for comprehensive and concise statement; in fact, it was pointed out years ago at a meeting of the American Society of Civil Engineers that better compliance with it would remove the necessity of a code. There is always more or less difference of opinion, however, concerning the application of general rules to specific cases, and it is for this reason that a detailed code of ethics seems to be desired by a considerable number of engineers. In discussing the subject, however, they seem to forget there is such a thing as law in the land, and the legal relations between engineers and their employees or clients will always have to be established by courts and not by the resolutions of technical societies. The courts have many times indirectly drawn a distinction between the rules of conduct which should govern an employee and those which are binding on a professional man. The consulting engineer, like the lawyer, physician and architect, who claims to possess certain specialized knowledge which he places at the disposal of clients for a fee, has to regulate his conduct by legal rules different in some respects from those governing salaried employees. While all these rules are based on the elementary principles of complete justice to everyone, the engineer who works on a salary is essentially a subordinate and not an independent adviser retained for some special purpose. It has accordingly been considered necessary by many who have looked into the subject of professional ethics with considerable care that the first step in formulating any code should be to draw a distinction between professional and salaried men which would recognize the legal obligations of the two classes and thus avoid the pitfall of impracticability. This is shown in the code printed elsewhere in this issue, in the distinction drawn between the property rights of consulting and salaried engineers in their plans and data.

Among the principles enunciated in the code referred to is one that the electrical engineer should incline toward and not away from standards of all kinds. This seems to be rather out of place in a code of ethics, although it might be entirely appropriate in the regulations drawn up by a company for the guidance of its salaried employees. Just what relation exists between ethics and the adherence to or departure from standards it is difficult to understand. The Engineering Record has always held the opinion that an engineer should adopt standard plans and purchase standard machinery when it was to the interest of his employers or clients to do so, and that he should prepare special designs when the standards were not so suitable as special methods or appliances would be. It has been pointed out by many men on many occasions that the innovation of today is the standard of tomorrow, and that progress is only possible by departing from standards. This paragraph is specially referred to because it indicates a feature of the code which seems to be open to a certain amount of criticism, the attempt to include in a code of ethics a number of rules which have no ethical relations. The same criticism might be made of the attempt to incorporate in the code certain legal relations which the courts must settle in any controversies between engineers and their clients or employers. For example, it is stated that the electrical engineer may not accept commissions directly or indirectly from parties dealing with his principals nor be financially interested in inventions and apparatus unless the matter is understood by the principals, statements which are governed by judicial decisions and are discussed in legal text books. Again, it is pointed out that operating engineers should consider themselves responsible for defects in apparatus or dangerous conditions of operation and should bring them to the attention of their employers and urge remedial action. If the causes of the danger are not removed, they should withdraw, according to the code. It might be pointed out that this subject is fully covered in the law of negligence and of master and servant, which are the subjects of many text books.

The portions of the code relating strictly to ethics seem to be confined mainly to paragraphs 22 to 35 inclusive, on the relations of the electrical engineer to the general public and to the engineering fraternity. These paragraphs contain suggestions regarding several relations of the engineer that are not often considered. For example, it is stated that the engineer should not engage in controversies of a technical nature in the daily press with other engineers. As a general proposition this is a good rule to follow. since the specialist who endeavors to conduct a technical controversy in the newspapers is almost certain to suffer in the end from doing so. His audience does not know what he is talking about, most of the time, and he will suffer in comparison with an ignorant man who is able to use English vigorously in the enunciation of ideas which are worthless. But occasions may arise when it is desirable in the interest of the public for an engineer to combat what he knows to be erroneous statements of another engineer in the daily papers. On several occasions in recent years eminent civil egineers have accomplished not a little of good by letters to the newspapers pointing out the defects of plans for public works drawn up by other engineers who were not entirely familiar with the subject, but probably did the best they could. In the opinion of The Engineering Record, therefore, rule 23 of the code of ethics is not wholly advisable. Another rule in the code, No. 32, states that the electrical engineer should not take a position left by another electrical engineer without satisfying himself that the former had left it voluntarily or for proper reasons. This rule seems to be meaningless, for who is to decide what are "proper reasons"? In the case of engineers engaged on a salary to discharge specific duties, it is difficult to see just what ethical rule is involved outside of the customary business relations of employer and employee.

In making these critiicisms on the code, the intention is not to attempt to belittle the excellent work done by the committee. They deserve the thanks of all who are interested in improving the relations of engineers among themselves and with their principals. It is a good thing that such a proposed code has been drawn up by men of the high standing of the committee which prepared this statement, for something definite is presented for discussion. The familiarity of the members of the committee with the difficulties facing engineers connected with manufacturing corporations has doubtless led them to lay more stress on what may be termed ordinary business relations than a committee of civil engineers would be likely to do. This makes the proposed code particularly instructive to civil engineers, for it furnishes a new point of view from which to regard a subject they have long discussed. It is also interesting as an example of an attempt to combine ethical maxims with principles of law and rules of business conduct. In this respect it departs from legal and medical codes which have been suggested from time to time, and opens up a new field of discussion.

Unit Bids in Machine Installations.

In the preparation of quotations to present to a prospective purchaser of machinery, time is usually very valuable in the district office of a manufacturing company. Requests for quotations come in by telephone and telegraph to be later confirmed by letters, and generally the information is wanted at the earliest possible date. Such conditions tend toward the production of blanket rather than detailed unit bids, unless the latter are specifically requested. The advantages of having figures submitted on a unit basis are thus often missed.

Under present-day conditions the completion of engineering and industrial designs requires the use of as much comparative data on similar work as may be available. An installation will be better adapted to its specific service if the data of other comparable work is considered in connection with it, even though the detailed conditions may differ very broadly. If quotations are submitted in an itemized form allowing for a certain range in the size and number of machines selected, these figures will be extremely suggestive and valuable in making future estimates and checks, and will also permit minor modifications to be made in the specific design in hand without delaying the course of events to anything like the extent which obtains if a single blanket bid is required on each set of assumptions.

Thus, in the case of a factory which decides to equip all its important machine tools with individual electric motors, it is of great value to secure the price of each motor as well as the total cost of the installation. Even though the power estimates be made with great care, there often arise modifications of the original plans which necessitate new figures from the manufacturers at short notice. At the last moment the company decides to replace certain machine tools by new outfits of an improved type or to carry the individual drive plan farther than was origiinally intended. Again, there may be a contraction in the amount of new apparatus decided upon, resulting from an economical turn at a directors' meeting. Accurate estimation of probable cost must be prepared within a few minutes' time in many such instances, and if the quotations are prepared on the unit basis as well as on the basis of a lump sum, it is ordinarily a simple matter to modify the wiring and installation figures in the time available, so that prompt decisions may be reached. When different types of motors are at issue, as in weighing the merits of commutating pole and induction outfits for a given shop, the facility of reaching decisions with the minimum delay depends in no small degree upon the presence of figures for each individual motor in the submitted quotations. Doubtless it takes longer in the first place to secure such individualized prices, and in some instances they are of course not needed from any standpoint, but in the majority of instances where the equipment is at all varied or complex in character, it saves time in the end to secure unit bids. As time passes and machines depreciate and have to be replaced at different times a company never regrets knowing just what the original unit cost was.

The Contracts for the Ashokan Dams.

Bids for the large masonry dam and for the appertinent earth dams and dykes for the Ashokan reservoir have been advertised by the Board of Water Supply of New York to be opened on the sixth of August. These great works are designed to impound about 120 billion gallons in a reservoir twelve miles long, constituting the largest impounding reservoir yet undertaken for a public water supply. It is one of the main features of the additional water supply system for the City of New York, which is estimated to cost, when completed, about $160,000,000. A comparatively small contract has already been awarded for the construction of nine or ten miles of the main aqueduct north of Peekskill, but the award of the contract for these dams will mark an epoch, so to speak, in the progress of construction of this exceptional public work.

The main dam across Esopus Creek, a half mile below Bishop's Falls, is chiefly of masonry and is about 230 feet high above its foundation in the rock, forming the bed of the stream at the dam site. Although it is a masonry structure of unusual magnitude it does not surpass the new Croton dam either in total height, or mass of masonry, or total length, but it possesses certain features which give it a distinct character of its own. There are no serious foundation problems to be met and solved as far as may be judged by the results of the examinations which have been abundantly made, and are available for the information of all bidders.

The features which will impress both engineers and contractors at first sight are the provisions for a series of wells throughout the length of the main masonry structure, placed a few feet from its upstream face, for the purpose of draining away any seepage, and a number of joints through the structure enabling it to be built up in sections and at the same time affording provision for expansion and contraction. It is not the first time that the drainage of seepage water has been introduced in a masonry dam, although this particular method of making the provision has probably never before been introduced in so large a dam. The operation of such features of masonry construction will, doubtless, be observed with great interest after the completion of the work. Although there is not much diversity of opinion among engineers regardng either seepage through masonry or the movement of masonry masses when free to move under changes of temperature, but there probably would be a rather wide range of judgment as to the necessity of severing such masses in the one case, or the introduction of a cellular arrangement in the other. In any event it is at least progressive to anticipate the prevention of certain features of the actual performance as observed in nearly all high masonry dams so far built. The results of such experiences will add substantially to the accumulating sum of engineering knowledge of masonry structures of magnitude.

An examination of the specifications and form of contract shows that they have been prepared with scrupulous care, both as to the city's interest and as to a fair and just attitude toward the contractor. There have been certain features of administration of public works contracts in the City of New York, which redound neither to the credit of the city as a reasonable agent in dealing with its contractors, nor to its efficiency in a business capacity. Progress estimates are often most unreasonably delayed in payment, and final estimates are not infrequently held up for many months after the satisfactory completion of the work. The Engineering Record has commented pointedly upon these features of public works construction, which, by their injustice to experienced and competent contractors, enhance correspondingly contract costs, and tend toward serious delays in the completion of the works affected by them. It is a matter of gratification therefore to find that the initial contracts in the series of greatest public works ever yet undertaken for any city disclose a radical change for the better in these respects, without in any way failing to safeguard with equal efficiency, the interests of the city. Although the aggregate of the bonds required amounts to $1,000,000 in addition to a certified cheque for $250,000 to accompany the bid, the payment of progress estimates is made obligatory within thirty days of date, and the final estimate within forty days of date. This provision is as wise for the city as it is advantageous for the contractor. The prices bid by the latter under such circumstances need cover only the legitimate costs of doing the work. The city puts itself on record as a prompt paymaster, and if there are any delays beyond the periods named, the municipality binds itself to pay four and one-half per cent. interest on the amounts due, and to make those interest payments practically a part of the immediately succeeding progress estimates.

These essential features of the contract for the Ashokan dams are unique in the history of New York City municipal construction. They cannot fail to be attractive to a class of experienced contractors whom it is desirable to secure as constructors of these works. In spite of the fact that the recent attempts to sell bonds for the city have not been successful the credit of the city is excellent, and there is no reason to believe that it will ever be otherwise, at least within any ordinary period of time. It should, therefore, avail itself of its good financial standing and improve every advantage which that condition offers. By prompt payments to contractors who have executed their works in a satisfactory manner, the prices tendered for public works will be reduced to a minimum by relieving the bidders of an interest account which they would otherwise have to carry. The Board of Water Supply has done well in making this fundamental departure from bad precedents and worse practice. It is safe to predict that it will secure highly satsfactory returns in reasonable prices and efficient prosecution of work.

Promoting.

The opportunities which engineers have for discovering water powers, locating new lines of railways and utilizing various natural advantages which they discover in their work are so many that some surprise is occasionally expressed that they rarely take advantage of their chances of this nature. Probably the reason is to be found in their lack of information concerning the manner in which to promote an undertaking of this sort. The word "promoter" has a very bad sound in the ears of many people. It stands for a man who makes glittering promises which are never fulfilled, in their opinion, whereas the real promoter is one of the most useful men a community can have. Through his knowledge of local conditions and insight into their capabilities he is able to suggest developments that are for the benefit of the district, and an honest promoter accordingly deserves local encouragement. It has been repeatedly noticed, however, that engineers do not seem to possess the faculty of stating their propositions of a new nature in such a form as to make them interesting to capitalists. They wrap the project up in all sorts of technical details which nobody but an engineer cares anything about and leave out the very essential facts which any man of business must have presented to him before he will even stop to consider a proposition. It is essential to have the technical details of any such enterprise worked out fairly well before the financial details can be stated, but it is the financial part of the proposition which is interesting to the capitalists, and unless that can be presented clearly, concisely and convincingly, he will not spend a moment's time in looking into it. These considerations indicate why it is that the successful launching of any enterprise makes a considerable expenditure of money necessary. People sometimes wonder why it is a capitalist takes no interest in the announcement that there is a water power capable of furnishing several thousand horse power within 15 or 20 miles of a large city. As a matter of fact there is no business interest to him in such knowledge. The time and money he would have to spend in investigating this statement can generally be made to yield a larger return if expended on his regular lines of business. Hence a good many people having knowledge of such opportunities for investment, who have presented them in a half-baked condition to capitalists, look upon the latter as extremely unprogressive and miserly men, when the fault really is due to the manner in which the propositions have been presented.

Before any proposition is likely to be of interest to capitalists it must be put on a business basis and this involves a great deal more than a mere rough estimate, made up some evening, of what it is likely can be realized from the resources to be developed if everything goes along happily. Take the case of a water power as an example. The mere existence of such a power is of no financial interest, as a rule. Unless the engineer and his friends have the money necessary to develop the power and construct the transmission lines to the nearest cities, then it is necessary to go to capitalists for financial help. In order to present the matter to them properly it is not only necessary to have a complete and conservative estimate of the cost of building all the works and of the immediate and probable future demand for power, but it is also necessary to have a completely organized company, with franchises, charter and options on all properties. Securing such evidences of good faith, which are necessary to enlist outside capital, involves the expenditure of considerable sums, and these it is absolutely necessary for the promoter and his friends to raise. Moreover, it rarely happens that the people who will underwrite a bond issue are willing to have any portion of the money they advance used for preliminary and prompting expenses. Although such expenditures are entirely legitimate and are to be considered as part of the capital necessarily embarked in the enterprise, it is essential that they should not be represented by anything more than a certain amount of stock in the enterprise. Failure to appreciate this view which is held by bankers and trust companies has been the rock on which a number of enterprises have been wrecked. People looking for help rather than giving it have to accept conditions as they are and cannot undertake to reform a money market condition which does not please them.

Large undertakings nowadays can be best brought to the attention of the public by an engineering promoter through one of the contracting-engineering companies which maintain banking departments. These companies do not undertake small enterprises, however, and the engineer who has a good thing in mind should do his best to interest local people in it before going to the large cities for capital. Moreover, it is necessary for him to arrange matters so that the capital which is advanced for preliminary expenses will be represented by stock, as before stated, for if any attempt is made to dispose of any part of a bond issue in return for money advanced for the purposes mentioned, the sale of the remaining bonds will be rendered practically impossible. Few people care to underwrite an issue of bonds unless the entire issue can be given to them, so that they can completely control the selling price. If this is not done and a few bonds are held by local people, circumstances may arise which will lead the latter to sacrifice some of these bonds for a low sum, thus establishing a price for them which will practically prohibit the underwriters from making any money on the bulk of the issue. It is also very necessary to have a thoroughly responsible lawyer pass upon every step of the proceedings, so that the validity of the bonds and the security of the investment in the undertaking shall be unquestioned. If a proposition has been investigated by engineers who are in good standing among capitalists, its proceedings are legally correct, and the undertaking has the backing of local bankers to the extent of their means, the project may be taken to the larger cities for final financial arrangements with some expectation of success.

Attention has been drawn to all these details because they emphasize the fact, which has been the wreck of a good many ambitions, that by the time all the work of launching a new enterprise has been carried through, the share of the promoter will have dwindled to a small percentage of the stock. This is a condition that must be recognized at the outset, for any promoter who seeks to retain control of an enterprise which he cannot finance is endeavoring to accomplish the impossible. All he can hope to do is to retain a reasonable share of the stock, so that, if his predictions come true under careful management, he will receive a reasonable return on the expenditure of time and money which he and his friends have made. Even this return must be foregone unless the original promoter takes care that all the preliminary steps of expert examination, incorporation, and preliminary organization are thoroughly well done and the local capitalists behind him are friendly and will use their good offices to prevent advantage being taken of him.

Notes and Comments.

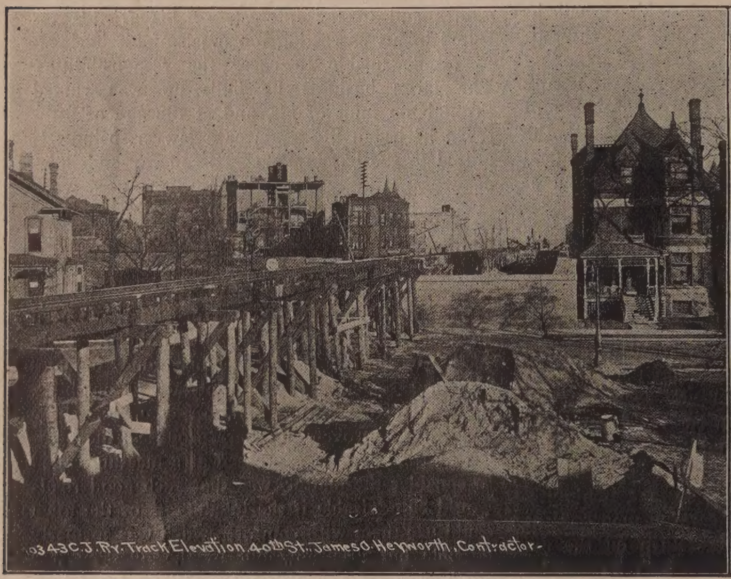
The Third-Tracking of the elevated railways on Second and Third Aves., New York, has luckily been brought up again for discussion, owing to the fact that such matters will be hereafter under the charge of the Public Service Commission, and its policy on such subjects has not yet been determined. The Board of Rapid Transit Railroad Commissioners which went out of office last month was positively opposed to adding a third track on these elevated structures, and for this reason no improvement of transit facilities on the Second and Third Avenue lines was possible. As a matter of fact third tracks have been laid on parts of both of these lines, and are used for storing cars when the traffic is light. The additional trackage to make the complete third lines will not be very great and the need for it seems so strong that a good many people in New York who have to do much traveling during rush hours have felt that the additional tracks ought to be permitted. It is true that an elevated railroad is not a thing of beauty, but it is also true that the addition of a third track at places where it does not already exist would be such a great advantage to a large portion of the public that the slight additional obstruction to light which its presence would cause would be more than outweighed by the benefits to be derived from it. Since the elevated structures are already in position, it seems good public policy to allow them to be utilized to the maximum.

Francis B. Thurber, who recently died in this city, was one of the valued advisers of The Engineering Record in its early days. The paper was established as a journal to spread a knowledge of sound sanitation. This included not only measures to improve plumbing in houses and the sewerage and water supply of cities, but also various important projects to insure purity in food products. His wide acquaintance with men in public life, his personal interest in the affairs of the city, and his knowledge of the measures necessary to prevent the injurious adulteration of food materials, made him a valued counselor, and placed The Engineering Record under obligations to him many times. In fact his willingness to devote a large part of his time to public affairs and to the interests of his friends resulted in his entrusting too much of his business to people unable to carry the responsibilities. The large business he built up was ruined through no fault of his, and at the age of fifty-seven he began life again as a lawyer, being admitted to the bar in 1899. His energy and independence, even when embarking on new work at an advanced age, won him the admiration of many who before had not fully appreciated his sterling qualities.

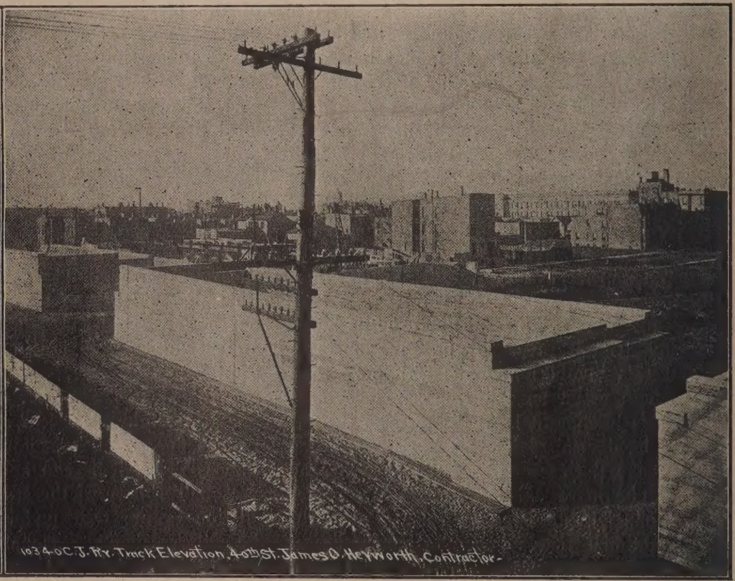
Several Road Improvement projects have been abandoned this year on account of the great objection of the taxpayers to paying money for constructing roads that would attract automobiles. At South Kingstown, R. I., for example, where important improvements were proposed, the opinion of the town, as expressed at a meeting called to consider the matter, was that such good roads would be advisable if the inhabitants of the town could use them with comfort, which was formerly possible but was now out of the question, for the high speed at which automobiles were driven through the town put citizens using the roads in peril of their lives. In view of the strong agitation for highway betterments which is being conducted by motor car enthusiasts, it might be well for them to consider carefully these instances of the determination to postpone road improvements until some laws were passed and enforced which will prevent speeding in towns. It will be recalled that the same revulsion of feeling regarding highway improvements occurred during the last few years of the bicycle craze, when the noisy mobs of cyclists made themselves so obnoxious in many localities that the residents preferred to go without the benefit of better highways than to be overrun on holidays and Sundays with a class of people distinctly undesirable. While The Engineering Record has no sympathy with the attempts of some towns to levy tribute on every owner of a motor car who goes through the streets at a speed above a crawl, it is thoroughly convinced that highway improvements will be more and more retarded unless laws are passed and rigidly enforced which will prevent the fast speeding of cars through streets. The clouds of dust and the odor of gasoline they leave behind them are unpleasant enough without being accompanied by the danger of life and limb to driver and pedestrian. A further evidence of the same feeling is to be seen in the vigorous protest from all parts of the State of New Jersey against permitting the Vanderbilt Cup race to be held there.

THE FORTIETH ST. TRACK ELEVATION OF THE CHICAGO JUNCTION RY.

The Fortieth St. branch of the Chicago Junction Ry., in Chicago, extends from a connection at Forty-second St. and Lake Michigan with the eight tracks of the Illinois Central R. R., north to Fortieth St. and thence west in that street for approximately 2½ miles to the Union Stock Yards. The tracks of this branch cross twenty-six city streets and a number of railroad tracks, over which the trains of eight trunk-line railroads enter the city. The branch provides an entrance to the Union Stock Yards for the following railroads: Illinois Central; Michigan Central; Cleveland, Cincinnati, Chicago & St. Louis; Lake Shore & Michigan Southern; Chicago, Rock Island & Pacific; New York, Chicago & St. Louis; Erie; Wabash; Chicago, Indianapolis & Louisville, and the Pennsylvania. In addition to the heavy traffic carried over the tracks of this branch between the Union Stock Yards and the various railroads with which it connects, a number of industries in the vicinity of the Yards contribute a large volume of traffic to it.


10343 C.J.Ry.Track Elevation 40th St. James O. Heyworth, Contractor.

Construction Work in Congested District.


10340 C.J.Ry.Track Elevation 40th St. James O. Heyworth, Contractor.

Section Extending from a Street to an Alley.

This branch of the Chicago Junction Ry. was built at the grade of the streets many years ago when the district through which it passes was an outlying residence district. The area on both sides of the branch for over a mile back from the lake is now one of the most populous of the better residence sections of the south side of the city; to the west from this area the district traversed by the branch is also quite congested, but grades off from the residence section into factories and other industries. Many of the streets which the tracks of the branch cross carry important north and south street railway surface lines and on several of these streets there is a large volume of vehicular traffic.

In order to eliminate the numerous grade crossings of streets and of the various trunk-line railroads the tracks of the Fortieth St. branch are being elevated on a fill carried between heavy concrete retaining walls. The South Side Elevated R. R. is also building a double-track branch line which closely parallels the branch of the Chicago Junction Ry. from Lake Michigan to the Union Stock Yards. The location and erection of the steel structure for this elevated railroad, the narrow right-of-way in which the construction work had to be carried on, the heavy freight traffic that had to be handled over the tracks which were being raised, and the necessity for keeping the streets crossed by the branch open for service at all times, rendered this track elevation work unusually difficult.

According to the new arrangement of tracks the Chicago Junction Ry. will have one, and the South Side Elevated Ry. two tracks for about ¾ mile from the lake front. The single track of the former rises on a grade from the lake until it is high enough above the street at the crossing of the first street west from the lake to permit that street to pass under the track. The two tracks of the elevated railroad are carried on a steel structure in this distance and thence continue at the same grade as the single track of the steam railroad for nearly three-quarters of a mile to a point where they rise on an incline and connect with the three main-line tracks of the elevated railroad. The steel structure on which these three tracks are carried parallels the steam railroad from this connection for about a quarter of a mile and then turns to the north and crosses over that railroad. From the point where these main-line tracks turn to the north a double-track branch line from the elevated railroad is being built to the stock yards; the two tracks of this line are on an elevated steel structure which spans the tracks of the Chicago Junction Ry. for several blocks, and then parallels them at one side to a point near the yards.

The Chicago Junction Ry. has two tracks for about a mile to the west from the point where the branch of the elevated railroad rises on the incline, and then three and finally several tracks just before entering the yards. In the entire distance from the lake to the yards the tracks are carried on a fill between two parallel gravity-section concrete retaining walls, the street crossings being made on through-plate-girder bridges having solid trough floors filled with concrete. These bridges are carried by concrete abutments and by a row of steel columns at each curb line.

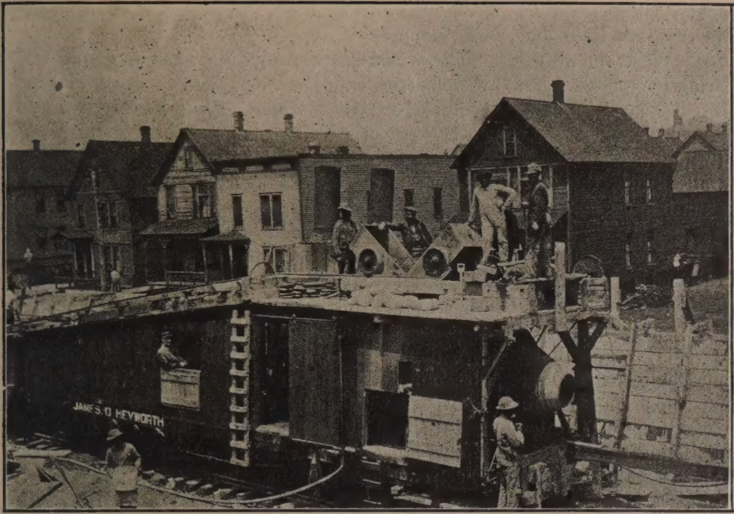
The elevation has a nearly uniform width for three tracks from the lake to within a short distance of the yards, where it widens out to accommodate the extra tracks. From the first street crossing at the lake to the point where the two tracks of the branch of the elevated railroad rise to connect with those of the main line, the track elevation carries the single track of the steam railroad and the two elevated railroad tracks. In this distance the city blocks are 400 to 550 ft. long, and as a 20-ft. alleyway is crossed on an overhead bridge between each two street crossings, the concrete retaining walls and the bridge abutments form a series of huge rectangular boxes half a city block in length.

The branch of the elevated railroad and the tracks of the Chicago Junction Ry. cross at right angles, a six-track elevation carrying the Lake Shore & Michigan Southern and the Chicago, Rock Island & Pacific railroads four city blocks to the west of the point where the main line of the elevated turns to the north. Formerly, the tracks of the Chicago Junction Ry. passed under this elevation; with the new arrangement these tracks cross this elevation on a single-span double-track through Pratt truss bridge. The elevated railroad will be carried over the track elevation on a separate bridge at one side and above the Chicago Junction bridge. The three crossings are thus made at three different grades, the street passing under the original elevation carrying the Lake Shore and the Rock Island tracks, the Chicago Junction tracks on the bridge being above that elevation and the tracks of the elevated railroad still higher, and at one side. In both directions from this crossing of the original track elevation the tracks of the elevated railroad are carried on a steel structure which spans the tracks of the Chicago Junction Ry., between a row of columns along each side of the right of way of the latter.

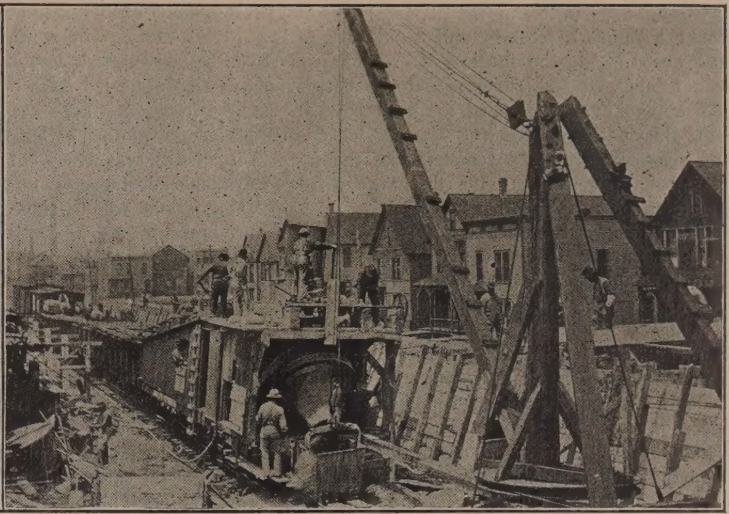
The tracks of the Western Indiana R. R., a terminal road on which several trunk lines enter the city, is also crossed at right angles by the tracks of the elevated railroad and of the Chicago Junction Ry. a short distance to the west from the crossing of the track elevation just mentioned. The elevation of the tracks of the Western Indiana R. R. to eliminate grade crossings has recently been completed at this point. The elevated railroad structure crosses over this elevation, while the Chicago Junction tracks drop down and pass under it at about street grade. The tracks of the latter rise again beyond this crossing and continue on an elevation into the Yards.

The grade of the tracks of the Chicago Junction Ry. at Halsted St., which is near the end of the present elevation, were formerly separated by carrying the street over the tracks on a three-span bridge with long fill approaches. This bridge has been removed, the 40,000 cu. yd. of material in the approaches to it are being taken out with steam shovels and the street will be carried under the track elevation. The elevation will be carried over this street on a bridge, the street being depressed somewhat to secure the necessary clearances.

The construction of the retaining walls for the track elevation and the placing of the fill between those walls have been carried forward in such order as the heavy traffic would permit. As a general method of progress, the footings for both walls were placed and one wall built



Dump Car in Partial Dumping Position.



One Type of Concrete Plant for Walls.

before tracks were raised. A track, or tracks as the case might be, were then laid on a temporary pile trestle erected over the completed wall, traffic being diverted over this trestle while the other wall was under construction, and until the fill had been made. The great volume of traffic to be handled, particularly on the tracks west of the crossing of the Lake Shore and the Rock Island elevation, and local conditions necessitated much diversion from this method. In places the fill was carried up under traffic and the retaining walls built later, the sides of the fill being held meanwhile by a cribbing of ties.

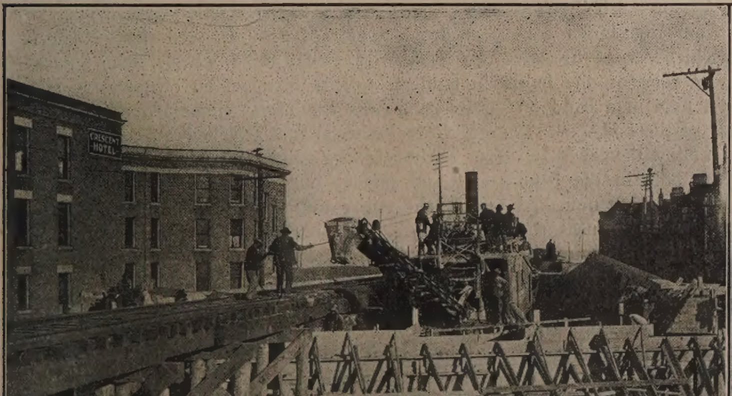
The portion of the elevated railroad structure which carried the three main-line tracks in the short-section where the latter parallel the tracks of the Chicago Junction Ry. had only two tracks and was partly over the site to be occupied by the elevation when operations were started on the latter. This structure was moved several feet to one side, raised 5 ft. and a third track added to it under traffic. A complete description of the manner in which this work was handled was published in The Engineering Record for March 3, 1906.

The excavation for the footings of the retaining walls for the track elevation was for the most part in sand or sandy loam which required the sides of the trenches to be sheeted closely in most of the work. The trenches were nearly all made with a Page scoop-bucket excavator, the sides of the trench being finished by hand. The sheeting was also driven by hand to prevent the loose soil sliding into the trenches.

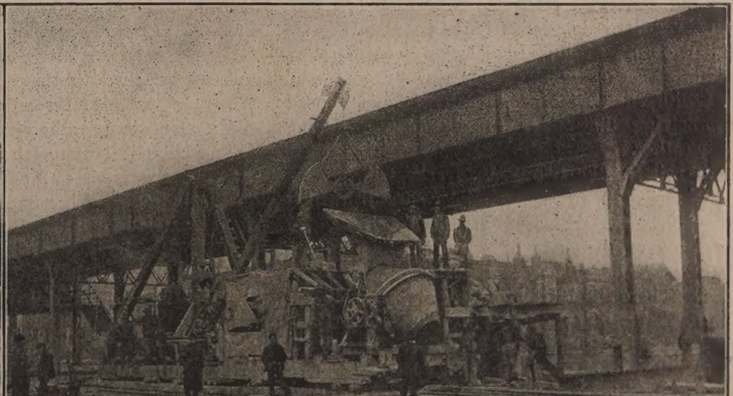
A portable concrete mixing outfit specially adapted to the work was used in placing the footings. This outfit was mounted on a 12 x 24-ft. platform carried by three pairs of longitudinal 8 x 16-in. stringers. This platform ran on rollers on a runway laid on each side of the trench for the footing. A 30 cu. ft. Smith mixer carrying a charging hopper was mounted on the front end of the platform so concrete could be dumped from it into the footing. The engine driving the mixer was also carried by this platform and storage space for enough cement in sacks to keep the outfit in service was provided at one side of the platform. The concrete for the footings was made in the proportions of 1 part cement to 8 parts pit-run gravel. The latter was delivered from the pit in gondola cars from which it was unloaded directly into the charging hopper of the mixer by a 1-yd. clam-shell bucket handled by a stiff-leg derrick. This derrick and the hoisting engine operating it were mounted on a second portable platform which ran on rollers on the same runways that carried the mixer platform. It was placed immediately in the rear of the latter with which it was moved back and forth along the work. The normal output of this outfit was about 220 cu. yd. of concrete per 10-hr. day, with 22 men, wherever the traffic conditions permitted steady running.

Owing to the limited space available this mixing outfit was generally set up at the intersection of a wall and the street and retained in one position until the footings on that side of the elevation had been completed for a half a city block each way from it. The mixer discharged into 1-yd. dump cars on four-wheel trucks, these cars being operated by hand on a 30-in. gauge track on each side of the trench for the footing. If more space had been available, the outfit could have been made readily portable so it might be moved forward as the work progressed. As it was, the single service track on which gravel was delivered was the only part of the right-of-way occupied by the operations on the footings, and this track was open for traffic when the mixer was not in service.

Two types of concrete mixing outfits were employed in building the retaining walls above the footings. One of these is very similar to those which have been employed on much of the track elevation work in Chicago. In this outfit a Drake mixer was mounted on the front end of a 34-ft. car, and together with its engine was protected by a housing, having a tight roof. A charging hopper surrounded by a working platform was built over the mixer in the roof of this housing. The pit-run gravel used in the wall was delivered in gondola cars, which were placed in a string of three or four immediately back of the mixer car. Plank runways were laid along the top of each side of these cars, leading from the latter up to the charging platform over the mixer. The gravel was hauled to the latter from the cars on these runways in wheelbarrows. The cement was kept in a box car at the far end of the string of gravel cars and was also delivered to the mixer in wheelbarrows. The mixer discharged on a traveling conveyor belt



One Type of Concrete Plant for Walls.



Concrete Plant for Wall Footings.

carried by a 30-ft. boom that could be swung through a radius of 90 deg. and could be raised and lowered at the end through 14 ft. The conveyor discharged the concrete into a bottom-dump hopper bucket attached to the end of the boom, this bucket preventing the gravel from being separated from the remainder of the concrete and also permitting the discharge of the concrete to be directed.

This outfit operated on a single track. It was moved forward or back by a cable attached to an anchor ahead and one in the rear of the string of cars, the cable winding around a drum driven by a set of gears on the deck of the mixer car. The engine driving these gears and the mixer engine were run by one man who also fired the two boilers which supplied steam to these engines.

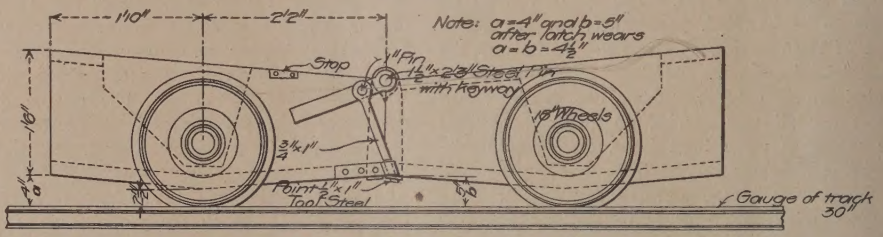
The other outfit used on the walls, although embodying similar general features of arrangement and operation, was entirely different from this first outfit in several important particulars. This mixing outfit was mounted on a standard-gauge double-truck car, 40 ft. long at the sills. A ¾-yd. Smith mixer and its engine were set at the front end of this car so the mixer could discharge into a bucket on a suspended platform just clearing the ground. A housing with a tight roof was built over the whole mixer car, a charging hopper being placed in this roof directly over the mixer. The gravel for concrete was delivered in gondola cars which were placed in a string of three to five in the rear of the mixer car; the cement was stored in sacks in a box car at the end of this string. A portable 30-in. gauge track was laid along each side of the tops of the gondola cars and extended up on the roof over the mixer car where the two tracks joined in a double-throw switch and were continued as a single track to the charging hopper of the mixer. The gravel and cement were delivered to the latter on these tracks in dump cars of a special type. The mixer discharged into a ¾-yd. bottom-dump bucket in which the concrete was handled to place in the forms by a stiff-leg derrick mounted with its hoisting engine on a second car.

The great drawback to portable concrete mixing outfits of types similar to this one, such as have been employed so extensively on track elevation work in Chicago, has been the difficulty and expense of delivering the concrete materials from the cars to the mixer. The details of the portable tracks used in connection with this particular outfit were so carefully developed, however, and the design of the special dump car used on them was so well adapted to the work, that 8 to 10 men could deliver the cement and gravel to the mixer as fast as the latter could turn out concrete; from 20 to 22 men are generally required in delivering the materials in similar outfits of this kind when wheelbarrows on runways are employed for this purpose, and even with such a force difficulty is experienced in supplying the mixer rapidly enough during hot weather.

The rails of the two 30-in. tracks which were laid the length of the gondola cars in which the gravel was delivered are both attached in pairs toward the ends of 4 x 6-in. tie timbers, 11 ft. long, the timbers being spaced 5 to 6 ft. apart. These timbers are laid transversely on top of the cars so one 30-in. track comes directly over each side of the cars. The rails are attached to the timbers by a special form of fastener, which is clamped to tie plates on timbers by a U-bolt and can be drawn from the plate by pulling a small latch and without loosening any bolts. The tie plates being firmly fixed to the timbers, the latter can be laid on the cars and the rails attached to them at gauge by the fasteners very quickly. The two tracks are rarely dismantled, however, when once set up on a section of work, as they are light and can be lifted readily in sections. When the gravel has been unloaded from a string of gondola cars, the two 30-in. tracks are lifted from them and placed on another string of loaded gondola cars on an adjacent track, or if no other cars are available, or there is no parallel track, they are set on light wooden horses until more cars are brought in.

As the gondola cars vary considerably in height, a bracket has been devised to carry the ends of the 4 x 6-in. track timbers, which permits the tracks to be brought to grade over low cars without any difficulty whatever. Each of these brackets is an A-frame built of wooden strips, the legs of the frame being double with the two halves of each leg spaced apart in order that the legs can be placed astride the side of the gondola car. The top of the frame is built to carry one end of a 4 x 8-in. track timber. A row of holes is made in each double leg of the frame, so bolts may be placed in these holes and the frames set at different heights by changing the positions of these bolts, on which the frame rests.

A special dump car used on these tracks was designed and patented by Mr. O. E. Strehlow, the patent being controlled by Mr. James O. Heyworth, the general contractor for this track elevation. The details of this car are shown in an accompanying illustration. The car has a long, low body built of steel plates; this body is divided in half at its transverse center line, the two halves being attached together on each side by a hinge at the top. Each half is carried by a pair of 18-in. flanged wheels with dust-proof bearings which are attached to the side of the body. Each pair of wheels is placed slightly toward the center of the car from the center of gravity of the half which they carry, but when the car is loaded the center of gravity of each half of the body is toward the middle of the car from the wheels. The two halves of the body are held horizontally by a latch on each side of the body, these latches each being attached to the hinge on the side of the body they lock. A lever extending from this hinge carries a ¾ x 1-in. latch strip which passes through a band attached to the lower edge of one half the body and also through a hole in a band on the bottom of the other half of the body.



Special Steel Dump Car.

The latch is loosened by pulling the lever and drawing the latch out of the hole in the band on the bottom. When both latches are unlocked the eccentric position of the wheels causes the center of the body to drop, the two halves of the body turning on the hinges so as to bring the ends of the body quickly together in an elevated horizontal position, thus discharging the contents along the bottoms of the halves, which are brought to a vertical position by the movement. The impact of the two halves coming together loosens the contents of the car and the body of the car is also shaped to facilitate the removal of the contents, the bottom, sides and top of both halves all converging toward the transverse center line. When the car is empty the center of gravity of each half is toward the end from the wheels so the car rights itself after it has dumped.

These cars are not any higher than an ordinary wheelbarrow and as they have a much lower center of gravity and greater wheel base than the latter, gravel can be shoveled into them with no danger of tipping and with greater speed. The cars each hold enough gravel for one charge of the mixer, but may be made any size desired. All parts of them have been made to stand the hard service to which they are subjected, with the result that two of these cars which have been in use for over a year are in practically as good condition as when new.

A double-drum friction hoist was placed on the roof over the mixer, and at the end of the track on which the dump cars were brought to the charging hopper of the latter. The shaft of this hoist was driven by a chain on a sprocket wheel on a shaft of the mixer engine. The cars were each drawn along the track and up to the charging hopper by a cable on one drum of this hoist. Two cars could thus supply materials to the mixer as fast as the latter could produce the concrete. The cement was delivered from the box car at the end of string to the platform around the charging hopper on top of the load of gravel in one of the dump cars.

A ¾-yd. bottom-dump hopper-shape bucket into which the concrete was handled from the mixer to place was also designed specially for this work. The bottom was made in two overlapping halves, each of which was hinged to the sides of the bucket and was arranged on the lever that controlled the two so the amount of opening could be varied. With this bucket concrete could be placed in comparatively narrow wall forms without difficulty.

The entire outfit, including the material cars and the derrick car were moved in either direction along the track by a traction gear on the car carrying the concrete mixer. This gear was driven by a 24-h.-p. duplex marine engine on the car. The shaft of the engine carried a 12 x 22-in. pulley wheel with a 11½-in. paper friction face bearing against a 12 x 32-in. iron rim pulley wheel on a shaft geared to the traction gear. The latter drove a pair of 2-ft. grooved sheave wheels for 1-in. wire cable, these wheels being placed in tandem, 4 ft. 9 in. apart on centers. A 1-in. wire cable was wound six times around the pair of sheave wheels and attached at each end to an anchor in the track; by winding up on one end and paying out on the other end of this cable the entire outfit could be moved in either direction. The sheave wheels were swung below the frame of the car and the cable brought on them at the under side from both ends in order to avoid any downward pull on the car frame.

The design and arrangement of this gear gave the latter enough power to pull the mixer car and five loaded material cars up a 5 per cent. grade. Since much of the track on this elevation work was raised between streets with material from the excavation for the wall footings, it was a succession of humps and grades during the time the concrete work was in progress, so this strong tractive force was of much value in moving the outfit along the wall as the concrete was carried ahead in horizontal layers. Furthermore, the placing of the gear below the floor and the general arrangement of the interior of the mixer car provided room for a coal storage space 8 ft. wide at one end of the car and ample space for the 42-in. vertical boilers which supplied steam to the two engines on the car.

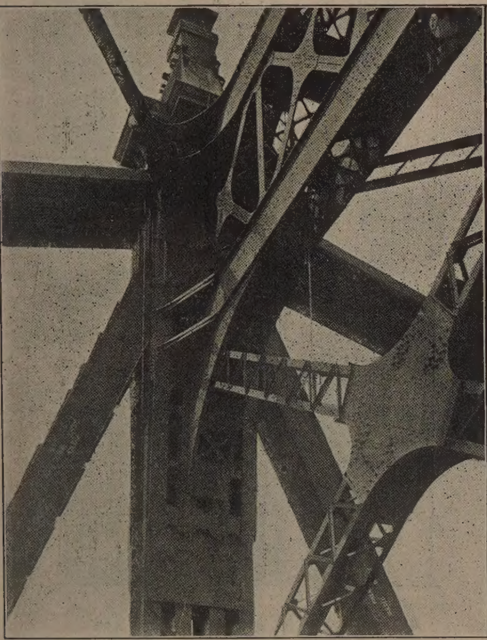
Mr. J. B. Cox is chief engineer of the Chicago Junction Ry.; Mr. O. F. Cole is assistant engineer in direct charge of the Fortieth St. track elevation. The contract for the excavation, concrete, timber work, pile driving, street depressions and so forth on this track elevation was carried out by Mr. James O. Heyworth, general contractor, of Chicago; Mr. O. E. Strehlow, M. Am. Soc. C. E., associate of Mr. Heyworth, devised and directed the construction and operation of the various special plants which have been described. Mr. Wm. Eesley is general superintendent for Mr. Heyworth. The principal item of the contract was 150,000 cu. yd. of concrete, although the pile-driving, timber construction and street depressions also constituted large quantities of work.

The Collapse of a Building into the excavation for a large structure alongside it, which happened in Cincinnati on July 2, calls attention to the necessity of thoroughly shoring all adjoining buildings when a structure is torn down and they are left exposed. The brick building which fell at Cincinnati was four stories high, about 120 ft. deep, and 22 ft. on the street front. It had been shored in the usual manner, according to reports, and its fall was probably due to the weakening of the shores. This may have happened in two ways, judging from the information at hand concerning the condition of the work at the time of the accident. One cause may have been the blasting of a large mass of concrete in the cellar of the building which was being torn down, while the other cause may have been the loosening of the wedges at the feet of the shores by the workmen who were clearing away the débris in the bottom of the excavation, where a large mass of refuse building material had been allowed to collect and was then being removed. It is often seen in the work of demolishing buildings that the class of men employed do not possess sufficient intelligence to appreciate the importance of keeping shores firm.

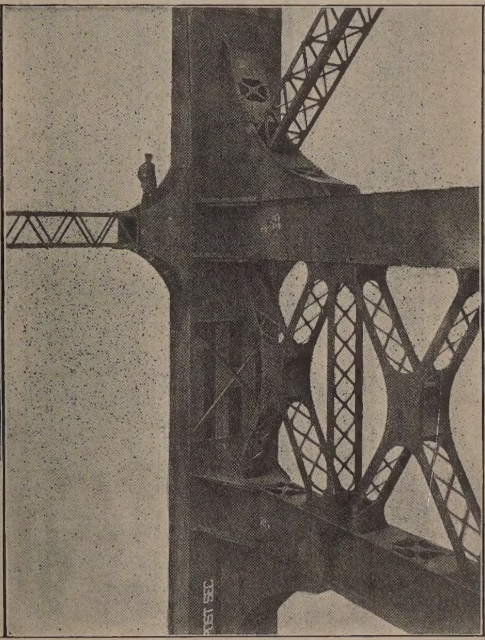
The Quebec Bridge Superstructure Details.—III.

The Upper Part of the Center Posts.—A maximum stress of nearly 16,000,000 lbs. is transmitted from the top chord of the anchor arm to the top chord of the cantilever arm through the top of each main post. Stresses of about 3,500,000 lbs. are also brought to the same point by each of the two main diagonal members converging there; these forces produce a resulting vertical stress of 9,900,000 lbs. in the upper part of the post which is made separate from the main part of the post and special in order to better provide for the transmission and resolution of stresses. The different members theoretically intersect at a common point where their center lines meet, and where, in ordinary construction, a single pin would receive all the members.

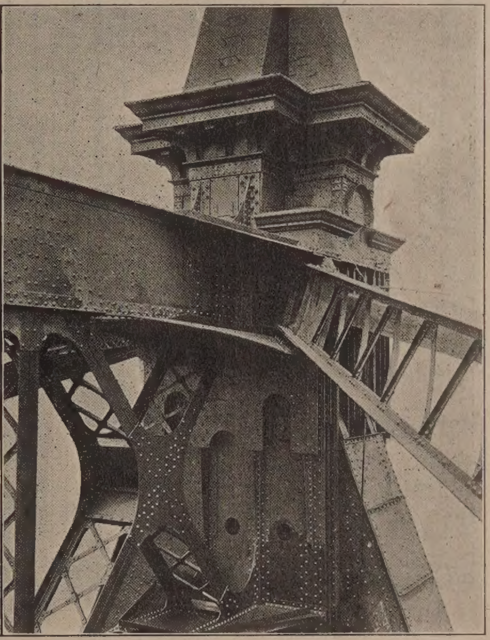
In this case, however, there are thirty 16x2-in. I-bars in each panel of the top chord, making 60 in all besides 12 webs for pin-bearing in the main posts and two webs for the bearings of each of the inclined members, thus making a total of 76 large bearings to be assembled at this point. If these were all grouped on a single pin, it would be impossible to reduce the bending moments enough to avoid making the pin of great diameter, and its length would require to be over 20 ft., dimensions which are obviously impracticable. The connection was therefore designed as a special unit to unite the different groups of members at this point and is virtually a complicated multiple link provided with four 12-in. pins, each of which receives only the bearing for a single member and transmits its stress to the link which distributes it among the other members. The heavy reinforced vertical longitudinal plates required for the bearings of the pins are connected rigidly by transverse diaphragms and an elaborate construction is provided to distribute the combined stresses on the four webs of the main section of the post.



Top Transverse Strut over Pier.



Strut over Roadway at Pier.



Top Connections at Main Post.

In order to limit the special construction to as small a member as possible, and to facilitate its assembling in the shop and particularly to reduce the dimensions to those conveniently handled in the boring and planing machines, this member was made entirely separate, as a cap, field connected to a horizontal bottom base plate in the top of the upper section of the main post. The cap is 10 ft. long parallel to the bridge axis, 9 ft. 8 in. wide at right angles to it, about 20 ft. high and weighs 230,000 lbs. The shop drawings for it include 19 main elevations and plans, besides several smaller sketches and details and entirely cover a 32-in.x12-ft. tracing which required the entire time of an expert draftsman for many months in its construction.

The cap has 12 longitudinal diaphragms or ribs connected by five vertical transverse diaphragms and, for convenience in manufacture and erection, it was made and shipped in three separate parts, assembled and bolted together on top of the main post. The two center ribs and the corresponding part of the horizontal base plate form one portion and the other two symmetrical portions each consist of five massive vertical longitudinal pin-bearing webs with their connected diaphragms and their base plates. Although nearly symmetrical about its longitudinal and transverse center line there are slight differences on the outer arm and cantilever arm sides which necessitate special construction throughout.

In order to make the pin bearings from 3 in. to 4 7-16 in. in thickness as required, the longitudinal webs of the ribs are made with plates ⅞ in. thick, reinforced on both sides with plates about ¾ in. thick. Their upper portions serve as short horizontal ribs connected to the eye bars in the outer and cantilever arm and the special reinforcement for ribs which do not receive the outer members are double pairs of ½-in. and 9-16-in. plates 10 ft. long. The eye bar pins engage all ribs and the upper ends of the latter are stiffened and connected by transverse diaphragms each side of the pins, four in all. The lower pins, for the diagonal members, although extending completely through the cap, engage only two pairs of webs on each side, the other webs being cut away to give abundant clearance for these pins.

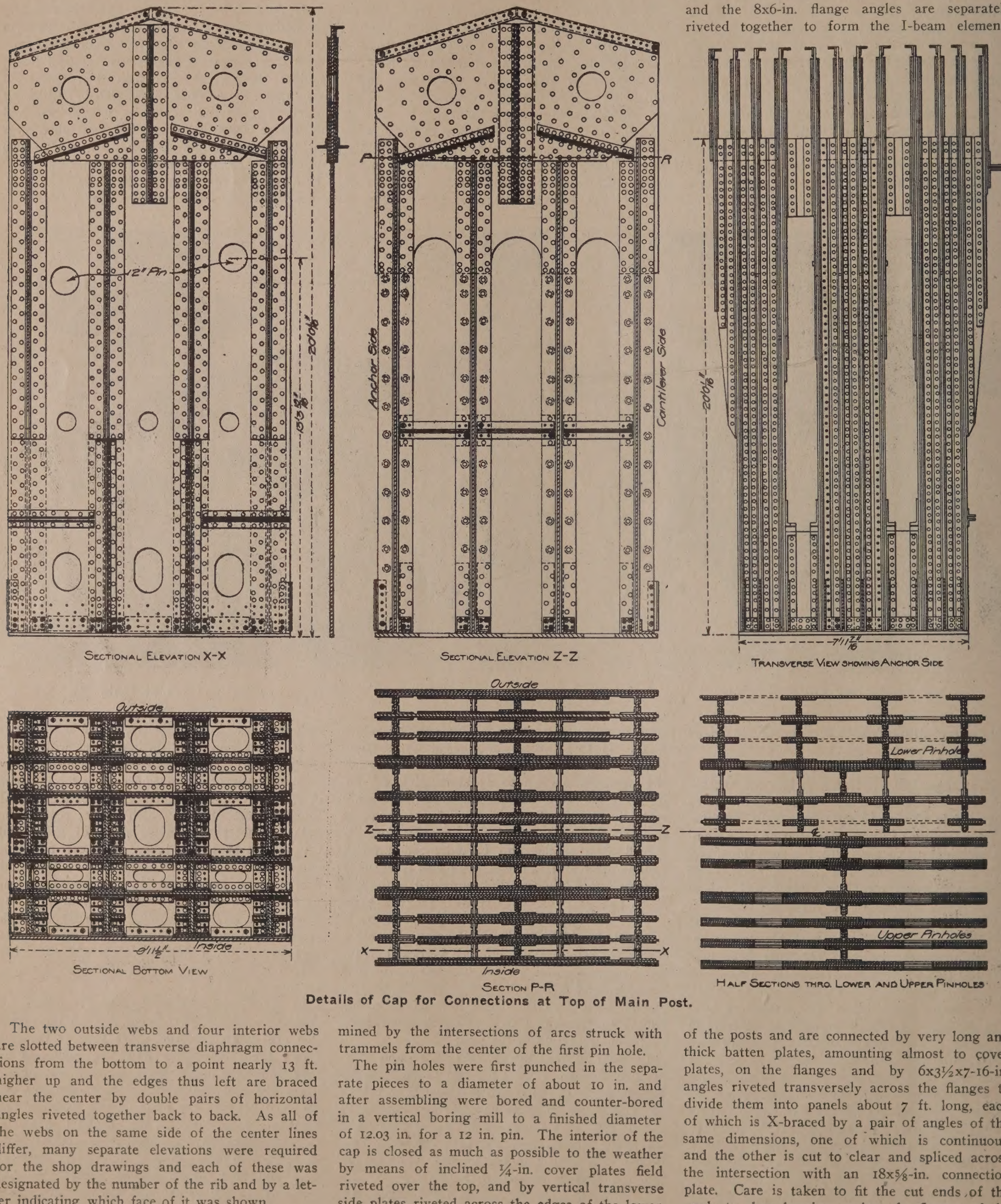
In order to clear the top chord eye-bars, all transverse diaphragms except that on the center line are omitted in the upper part of the cap. Below the eye-bars the webs are connected by four transverse diaphragms, one each side of the lower pin, and additional center diaphragms are provided between the pairs of ribs which afford bearing for the pins in the diagonal members. All diaphragms have I-shaped cross sections made by single web plates from ½ in. to ¾ in. in thickness and four flange angles except the diaphragms on the center line between the outer webs which are made with double sets of vertical angles back to back, forming T-shaped cross sections which engage each other and are riveted together through the outstanding flanges. Rivets ⅞ in. in diameter are used wherever possible, but where there is not sufficient clearance to drive them and in the connections between the different sections of the cap and between the cap and the top of the post a large number of turned bolts are required and a number of hand holes are left to give access to them.

The two outside webs and four interior webs are slotted between transverse diaphragm connections from the bottom to a point nearly 13 ft. higher up and the edges thus left are braced near the center by double pairs of horizontal angles riveted together back to back. As all of the webs on the same side of the center lines differ, many separate elevations were required for the shop drawings and each of these was designated by the number of the rib and by a letter indicating which face of it was shown.

As the adjacent cantilever and anchor arm trusses are not duplicates the pin holes for their connection to the cap are not symmetrically arranged either with regard to each other or with regard to the center lines of the member, but are located at the vertices of a trapezium with sides from about 5 ft. to 6½ ft. in length. One hole was carefully laid out in the top with reference to the longitudinal and transverse axis of the post, and the other holes were located from it by triangulation, their centers being determined by the intersections of arcs struck with trammels from the center of the first pin hole.

The pin holes were first punched in the separate pieces to a diameter of about 10 in. and after assembling were bored and counter-bored in a vertical boring mill to a finished diameter of 12.03 in. for a 12 in. pin. The interior of the cap is closed as much as possible to the weather by means of inclined ¼-in. cover plates field riveted over the top, and by vertical transverse side plates riveted across the edges of the lower end of the longitudinal webs below their points of intersection with the diagonal members.

The main vertical post 315 ft. long on centers has in addition to the special top and bottom sections, five main sections with field riveted butt joints. Their lengths vary from 50 to 76 ft. and their maximum weight is over 100 tons. The total combined maximum stresses amount to 11,928,000 lbs., for which a cross sectional area of 526 sq. in. is provided by four webs which with their flanges and cover plates build up the 4x10-ft. rectangular section. The 48-in. web plates and the 8x6-in. flange angles are separately riveted together to form the I-beam elements of the posts and are connected by very long and thick batten plates, amounting almost to cover plates, on the flanges and by 6x3½x7-16-in. angles riveted transversely across the flanges to divide them into panels about 7 ft. long, each of which is X-braced by a pair of angles of the same dimensions, one of which is continuous and the other is cut to clear and spliced across the intersection with an 18x⅝-in. connection plate. Care is taken to fit the cut ends of the angle to close bearing against the flanges of the continuous X-brace angle.



Sectional Elevation X-X

Sectional Elevation Z-Z

Transverse View showing Anchor Side

Sectional Bottom View

Section P-R

Half Sections thro. Lower and Upper Pinholes

Details of Cap for Connections at Top of Main Post.

The lower section of the post, 51 ft. 9½ in. long over all, is typical of the other sections and varies from them chiefly in the minor details of connections with the transverse bracing and with the top and bottom portions of the posts. The splice which is typical of the other splices in the same member has about 1,000 field driven rivets and is made with single cover plates on the flanges and with double cover plates on each side of each of the four ends. All of the splice plates are shop riveted to the lower section of the post and project beyond it, forming jaws to receive the field riveted lower ends of the webs of the section above. At the lower end of the post the 119½x¾-in. cover plates are about 18½ ft. long and have in the outer edges about 500 field driven rivets for the connection with the main inclined post. The lower ends of the webs are united both by their cover plates or battens and by two lines of vertical longitudinal shop riveted diaphragms which strengthen it and tend to distribute the load uniformly and stiffen the 65x1⅝-in. base plate 10 ft. long to which it is connected by horizontal flange angles. Very great care is taken to fit the lower edges of the main webs and diaphragms to accurate bearing on the base plate which is planed on both upper and lower surfaces and is connected to the horizontal upper plate of the pedestal by a large number of field driven rivets. Just above the base the cross section is divided into nine rectangles by the webs and diaphragms and just below the splice it is stiffened by angle frame horizontal X-braces.

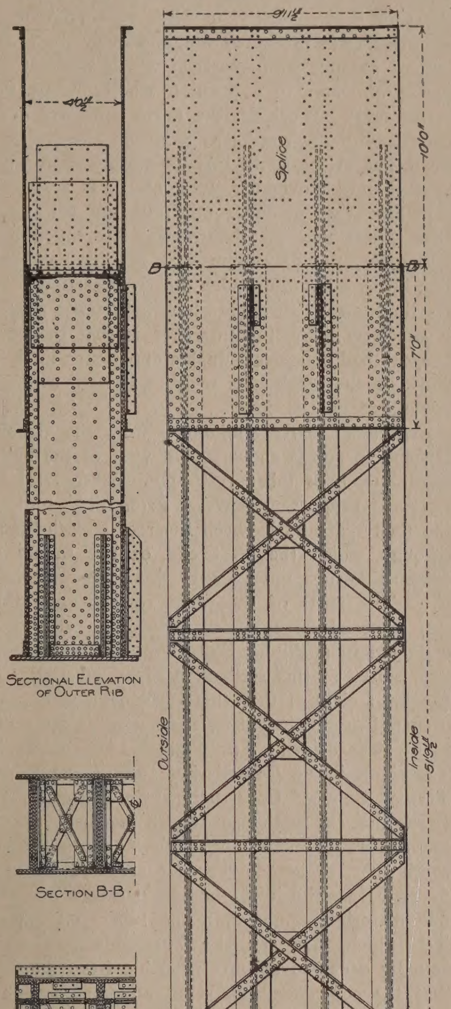
(To be Continued.)

A Gravity Water Supply at Montrose, Colo.

The town of Montrose in the western central part of Colorado formerly obtained its supply of water from the Umcompahgre River. During the summer months this stream is practically diverted for irrigation purposes before the waters reach Montrose, with the result that the only supply available from it in the late summer is that which returns to the river in the form of seepage. This seepage is highly impregnated with alkali and contains a large amount of organic matter. The water is consequently almost impossible to use for laundry or manufacturing purposes on account of the hardness, and during the time it was the source of the domestic supply several epidemics of typhoid fever occurred in Montrose.

The only other available supply that could be obtained was from the Cimarron River, which is 30 miles or more from Montrose, a high divide separating the latter from it. This river had been tapped, however, by an irrigation company, which operates a ditch carrying about 100 cu. ft. per second across the divide into the valley of the Uncompahgre River. At the top of the divide, known as Cerro Summit, a reservoir site covering about 19 acres was obtainable by the construction of a dam about 480 ft. long and 35 ft. in height. This site is at an elevation of approximately 7,800 ft. above sea level, the elevation at Montrose being 5,800 ft. The quality of the water delivered to the reservoir by the irrigating ditch is fairly good, but from the reservoir to Montrose the soil contains a large amount of salts, making it impossible to carry the water from the reservoir to the town through an open channel. The high rate of evaporation in the dry climate and at the high altitude also made an open ditch undesirable. As the distance from the reservoir to the town is about 14 miles, the method of conveying the water became a very serious one. On the basis of an estimate prepared, it seemed probable that the town could not raise sufficient funds to construct an iron pipe line. The nearby town of Delta had experimented under somewhat similar circumstances, with glazed tile pipe, with seriously disappointing results. Consequently, a wooden stave pipe conduit was adopted.

The contract for the construction of the dam, a 10-in. wooden stave conduit, slightly over 14 miles in length, and about 10 miles of cast-iron distribution mains in Montrose was awarded to the American Water & Light Co. in the spring of 1905. These works have since been completed and the whole system is in satisfactory operation.



Lower Section of Main Post.

An earth fill dam having a puddle core wall was built to develop the reservoir site. This dam is 10 ft. wide and 480 ft. in length at the crest, 35 ft. in height, has a 1 on 3 slope on the upstream side and 1 on 2 slope on the downstream side. A low dam 320 ft. long at the crest and with the same slopes as the larger dam was also built across a saddle near one end of the latter. Both dams have their upstream slopes paved with 6 in. of gravel to the top, although an overflow prevents the water reaching a depth of over 30 ft. at the dam.

The puddle core wall of each dam was built in a trench carried 5 ft. below the natural surface. The core wall of the main dam is 10 ft. wide from the bottom of this trench to the natural ground surface, above which it has a batter of about 1 in. to the foot to its top, 32 ft. above the ground level. The ground rises from the center of the dam toward both ends. This rise was overcome in the core wall by cutting steps having 1-ft. risers and 5-ft. treads in the bottom of the core wall trench.

The outlet from the reservoir is a 4ft. circular screen chamber, 32 ft. high, built in the dam. The water may be drawn from the bottom of the reservoir, or from a point 11 ft. above the latter into this chamber, the outlet from which is an 8-in. cast-iron pipe laid in concrete to the downstream toe of the dam, where it connects with the wooden stave conduit.

As the reservoir is 2,000 ft. above the town, the pressure had to be reduced at intervals along the conduit. This reduction is obtained at each point by a special reducing valve placed in a small valve chamber. Whenever the difference in elevation reached 200 ft., one of these valves was inserted and the pressure reduced to that of the atmosphere so no section of the pipe stands under a greater hydraulic head than 200 ft. Ten of these valves and valve chambers were, therefore, installed. These chambers are 6x8 ft. in plan and have concrete bottoms and side walls 6 in. thick. A gate valve is placed on the conduit immediately inside the chamber and just beyond this valve is the one in which the pressure is reduced. The outlet from the chamber is through a 10-in. strainer on a free end of the conduit.

The pipe was all laid with a cover of at least 4 ft. in the trench. The latter was largely all made with a Buckeye traction ditching machine. For the first 6 miles from the reservoir the trench was blasted out of the rock in the side hills to a considerable extent. Most of the remaining 8 miles of the trench had to be made through cementing gravel, which could only be moved with a pick when taken out by hand. The ditching machine was very successfully and economically employed in all of the trench over this 8 miles, working over the rough places in the line without any difficulty. It was also used with good results in making the trenches for the distribution mains.

Some trouble was experienced at first in making the wooden stave conduit tight, owing chiefly to the fact that the wood had not been properly seasoned before it was delivered. The leaks were caulked after the line had been in use for some time, and at present the conduit is in good serviceable condition.

A Heavy-Capacity Car of unusual proportions has recently been built for the Bethlehem Steel Co. by the Philadelphia & Reading Ry. for the transportation of castings weighing 125 tons. This load is distributed on 32 wheels, grouped in four eight-wheel trucks. The load is carried in a "well," formed between two 6-ft. plate girders 67 ft. in length, which taper at the ends, and rest on center-plate frames of 26-in. plate girders, 20 ft. long, that are supported by two of the 8-wheel trucks. The "well" accommodates castings 5x24 ft. in size by 12 ft. 10 in. high, and the load is distributed over a total wheel base of 94¼ ft., of which but 12¾ ft. is rigid.

An Official Examination of the Battery Tunnel, New York.

Owing to numerous statements in the daily papers concerning the condition of the Battery tunnel between Manhattan and Brooklyn, Mayor McClellan instructed Mr. Nelson P. Lewis, chief engineer of the Board of Estimate and Apportionment, to make an examination of the work. This has been done in a thorough manner, everybody connected with the undertaking placing all information in their possession at the disposal of Mr. Lewis. As a result of his inspection of the tunnel and examination of the records of the engineers and contractors, he submitted last week an instructive report, from which the following notes have been taken:

Both cast-iron tubes have been completed for their entire distance. In the north tube the concrete lining and the ducts are practically complete from the Manhattan end to the lowest point, which is near the middle of the East River, where the tube leaves solid rock, while the bottom lining has been carried about to the point where the tube enters the reef of rock about 600 feet further east. There is nothing but the cast-iron shell from this reef to the Furman St. shaft, while from this shaft to the Brooklyn end of the tube the greater part of the concrete lining and some of the ducts are in place. The concrete track invert has been placed for the short distance between the Manhattan end and the Battery Park Shaft.

In the south tube the concrete lining, ducts and track invert are practically complete between the end of the tube and the cross tunnel at the lowest point, and the cross-ties are in position for the greater part of the distance. From here to the Furman St. shaft there is nothing but the cast-iron tube, while from Furman St. to the Brooklyn end of the tube the lining and ducts have been completed.

The portions of the tubes which have been built in rock are in excellent condition, and the work is so far advanced that tracks could be laid and this part of the tunnel made ready for operation in a very short time. Where soft material was encountered great difficulties were presented, and there were variations from grade and section which had to be corrected.

Variations from Theoretical Grade.—North Tube: Beginning at the Brooklyn end the bottom of the tube is about 4 inches below the theoretical grade, this variation decreasing toward the west to a point just east of Garden Place, where the tube suddenly rose to 9 in. above grade, then gradually approached true grade, crossed it about 100 ft. east of Hicks St., and 100 ft. west of Hicks St. dropped to 28 in. below grade, this being the greatest departure. Up to this point the tunnel is wholly or in part above water level. The true grade was recovered in the next one hundred feet, and from there to the bulkhead line the tube bottom was mostly above grade, the maximum distance being about 10½ in., while at one point it fell 9 in. below the grade. After crossing the bulkhead line the tube continued above the theoretical grade for over 500 ft., the maximum variation being seventeen inches. It then ran very closely to the true grade for about 500 ft., and within the next 100 ft. it reached a maximum of 18 in. below grade. For the remaining 200 ft. before the rock reef was reached, the grade line was somewhat irregular.

South Tube: The grade of this tube from its easterly end shows slight variations from the true grade, with a maximum of about 5 in. above and below, but after passing Hicks St. there is, as in the case of the north tube, a more noticeable departure, dropping to about 23 in. below the true grade, which, however, was quickly recovered and was closely followed to the bulkhead line, the maximum variations in this distance, which is about 900 ft., being 3 in. above and somewhat less below the true grade. In both tubes the maximum departure from grade occurred just west of Hicks St., or at the point where the tubes became wholly submerged. Work was in progress on both tubes at this point at the same time, namely, in May, 1904, so that in both cases was presented simultaneously the problem of passing from material which was dry or partly in water to a position wholly below the water level. Work on the north tube was continued, with the results as to grade already outlined, but in the south tube operations were suspended until November, 1904, and it is a significant fact that in the south tube the variations from grade and the deformation are much less noticeable, the maximum east of the bulkhead line being 3 in., and under the river section 6 in. As the material through which both tubes passed is precisely alike, the inference is that the contractors had gained a valuable experience in their work on the north tube which was used to good advantage on the other.

Settlement After Building.—From the Brooklyn end to points about 500 ft. west of the bulkhead line, both tubes rest upon coarse sand of excellent supporting power. From this point to the rock reef and between the reef and the rock through which the west end of the tunnel is driven they rest upon a very fine sand and river silt. The parts of the tubes resting upon this soft material have settled somewhat since they were put in position. Statements as to the time and causes of this settlement are conflicting. It has been claimed that this settlement may have occurred gradually during some months after the tunnel was driven. The engineers of the Rapid Transit Railroad Commission and of the Rapid Transit Subway Construction Co. assured Mr. Lewis that the settlement, which reached a maximum of 12 in. in the north tube and 9 in. in the south tube, occurred when air pressure was reduced before the joints had been calked and the fine material coming into the tubes left spaces into which they settled. That this was what actually occurred appears probable from the fact that the contractors made an attempt to adjust the grades by opening the bottom of the tubes at high points in order that material might flow into them, thus causing them to settle to a uniform grade line, and it is said that in this they were partially successful. So far as Mr. Lewis could learn there has been no perceptible settlement during the past year.

Supporting Piles.—In order that further settlement may not occur either through inherent lack of supporting power of the soft material above referred to, or through any change in the character of the material may possibly be caused by the vibrations due to train movement, supporting piles are now being placed under those portions of both tubes which rest in this material. [This work has been described in detail in this journal.] In the space west of the rock reef these piles are being driven about every 35 ft. East of the reef and until the tubes reach coarse sand, the piles are placed about 50 ft. apart. These piles are in pairs, 7 ft. apart between centers, each pile consisting of a steel tube 20 in. in diameter filled with concrete and reinforced with steel rods and hoops. Each pair of piles supports a cradle made of concrete strongly reinforced with steel, this cradle being 11 ft. long and 5½ ft. wide, equivalent to three rings of the tunnel tube.

Under the north tube all of the supporting piles have been put in place east of the reef, and all but seven west of the reef. Under the south reef five pairs remain to be driven to the east and eight pairs to the west of the reef. There will be 63 pairs of these supporting piles, all of which will go to rock or hard pan, their length varying from 4 ft. to about 75 ft. This work is being done very rapidly, and will be completed in about three weeks.

Deformation of Tubes.—Flattening occurred in both tubes and was most noticeable where there were sharp changes in the grade lines. If a ring of the tunnel were to be tightly bolted together and placed in a vertical position, there would undoubtedly be a certain amount of flattening, which would be increased by any loosening of the bolts. This flattening or deformation is most noticeable in the land section, reaching its maximum as in the grade variation about where the tubes became entirely submerged where it was about 10 in. in the north and about 7 in. in the south tube. Between this point and the bulkhead the south tube, which followed the grade more closely, showed a maximum flattening of less than 4 in., and still less under the river.

Correction of Grade and Section.—Where the departure from grade and section has been sufficient to interfere with passage of trains or to endanger the integrity of the tubes, the plates have been removed and concrete, and in one case brick masonry, has been substituted, in some places for the roof, and in other places for the bottom above the water line, while under water new plates giving an elliptical section with the longer diameter vertical have been put in place of the old ones. This was a very difficult undertaking, but it has been successfully done by the use of novel and very ingenious methods. [These have been described in detail in this journal.]

Cracked and Broken Plates.—Much has been said about cracked and broken plates. By far the greatest number occurred on the Brooklyn land section of both tubes, where the material was coarse sand and gravel and where the tubes were wholly or in part above water, and, as in the case of the flattening, they are most noticeable where there are sharp changes from the true grade line. This would appear to indicate that the cracking of plates was not due to the inability of the tubes to retain their shape or to perform their proper functions after they were in position, but to the stresses to which they were subjected by the irregular course of the shield when it departed from the proper grade and the efforts to bring it back to grade after such departure. There are few cracked plates in the river section, especially in the south tube, and Mr. Lewis was informed that nearly if not quite all of the cracking occurred immediately behind the shield during the progress of the work. None of the cracked plates appear to be lacking in that part of the tubes east of the Furman St. shaft, although for about 600 ft. the tubes are entirely below mean high tide. In the portions which are still under air pressure Mr. Lewis could see no leaks either at the joints or from cracked plates, but some may develop when the air pressure is again removed. They can, however, be stopped as have been those east of Furman St.

The inability of the tubes to retain their shape and carry moving trains without leaks, settling and deformation, depends upon the character of the material in which they lie. This material, except for about 800 ft. east and about 600 ft. west of the rock reef, has ample supporting power. As to the very fine sand and river silt on both sides of the reef, there is a difference of opinion. Mr. Lewis examined a number of samples, most of which were taken from under the tubes when plates were removed for the purpose of sinking the supporting piles. Some of these samples are in water, while others are dry. The former appear to be nearly all very fine sand, while the latter have the appearance of a putty-like mud, although all contain a large amount of exceedingly fine sand. While some of the engineers who have this work in charge seem confident that the fine material on each side of the reef is capable of supporting the completed tubes with the moving trains, it is realized that the problem is a novel and difficult one; that tunnels are now being built beneath both the

Hudson and the East Rivers under conditions which have not been found elsewhere; that the tubes, if not otherwise supported, will settle if the underlying material flows into them; that in one of the Hudson River tunnels the original plans called for supporting piles, and that it is, therefore, prudent to insure against settlement by the supports now being put in place.

That the most unfavorable material encountered has considerable supporting power, there can be no doubt. Should this prove to be even less than was believed when it was decided to introduce the supporting piles, the number of these supports can be increased at any time.

Difficult Cofferdam Work on Decomposed Rocks.

A discussion of recent improvements in steel sheet piling elicited some reminiscences of difficult cofferdam work accomplished with heavy wooden sheet piles where troublesome conditions of an unusual character were overcome by simple expedients that are suggestive for similar work under other circumstances.

Several years ago a massive sea wall about 40 ft. high and 114 ft. long was built by the Department of Docks at the foot of East 116th St., on the Harlem River, New York City. The bank and river bed were of mud and miscellaneous fill and peat down to the surface of the characteristic gneiss rock which had an irregular surface sloping from about 15 to 34 ft. below high water level. The footings at both ends of the wall were close to those of buildings which it was dangerous to disturb, and the space at the south end was occupied by an old timber and stone filled crib which made excavations especially difficult. A sewer also crossed the site of the wall and was supported only on the earth and fill. A portion of the bottom at the south end had been badly broken up by dredging and the conditions were such that it was not considered practicable to build the wall with the standard large cast concrete blocks usually adopted by the Department of Docks in New York City. It was therefore decided to enclose the wall by a cofferdam and build it with concrete placed in moulds in open excavation.

A cofferdam about 114 ft. long and from 20 to 25 ft. wide inside, was therefore constructed with some difficulty with 6-in. splined wooden sheet piles driven to the surface of the rock which they penetrated about 1 in. When exposed it was found that the surface of the rock, apparently sound and hard, had been badly decomposed to a considerable depth, perhaps by the action of the peat, and that although firm and quite hard, it could be easily cut by a pick or shovel and when removed in small pieces could be crumbled to fine sand.

When the sheet piles were first driven it was sufficiently solid to afford bearing for them and exclude a large part of the water, but as the interior of the cofferdam was pumped out and the unbalanced pressure on the outside became large, the surface of the rock was rapidly cut out and water entered under the bottoms of the piles in very large quantities so that it soon became impossible to pump it all out and it was necessary to keep up an almost continual redriving of the piles, going around and around the cofferdam and forcing them down as fast as they were undermined.

In this way they were gradually sunk to sounder rock 1 or 2 ft. below the original surface and at the same time a large amount of good puddle clay was dumped around the outside of the cofferdam and protected the feet of the piles so that eventually the leaks ceased and the dam was made good everywhere except at the upper end where the surface of the rock was only about 10 ft. below low water level. Here a large boulder intersected the end of the cofferdam and stopped the sheet piles which brought up hard on top of it with their upper ends forming a curved line extending above the tops of adjacent piles and corresponding exactly with the profile of the boulder. The boulder was lodged in a fissure in the rock bottom, under which the water entered the cofferdam in a great volume.

Efforts were made to close the fissure with cement, concrete and sand, but it was very difficult to place them and it proved impossible to close it entirely, although the leak through it was somewhat diminished so that finally it could be controlled by the operation of one 8-in. and one 6-in. centrifugal pump and one 6-in. and one 3-in. pulsometer. When all of these were working to their full capacity the cofferdam could be emptied, but if any one of them was out of service for a short time the remainder could not control the leak and the cofferdam would be flooded.

Finally, an interior cofferdam of sand bags was built to partly enclose the end of the boulder, where it projected inside the cofferdam, and divert the leak at that point to the opposite side of the main cofferdam. Behind this protection a curved concrete wall about 3 ft. high was built forming a quadrant with one end abutting against the end wall of the cofferdam. In it there were placed two or three large drainage pipes and after the wall was completed the pipes were opened, allowing the flow from the leak to pass through them into the bottom of the main cofferdams while the temporary sand-bag cofferdam was removed and rebuilt on the other side of the boulder, diverting the flow from that portion of the cofferdam where it had previously been. Under its protection, an additional section of curved concrete wall was built connecting with the first quadrant and with it making a semi-circular curb 9 ft. in diameter, with both ends abutting against the end wall of the main cofferdams and entirely enclosing the boulder, fissure and leak. Six-inch outlet pipes were also built into the bottom of this part of the curb wall but were temporarily closed while the water from the leak flowed through those at the other side and was conducted to a large deep sump in the body of the wall in the middle of the cofferdam, which was maintained until the concrete covering the face of the rock was built up to its level when another sump was formed on the opposite side of the cofferdam.

The ends of the pipes leading to the first one were closed with wooden plugs and the sump itself filled up. The second sump received the flow from the leak through the other set of pipes and enabled the bottom to be kept sufficiently dry to permit concreting on the opposite side until the level of this sump was reached when the same operations were repeated, building successive sumps on both sides until finally the general level of the concrete was brought up to the top of the curb enclosing the boulder and a wall was continued up to low water level after which, of course, it was easy to fill in with concrete over the boulder at low tide, thus completing the foundations. The work was done in successive halves on both sides of the cofferdam while the water was flowing violently over the opposite half. The sumps were large enough to maintain a constant body of water for the pump suction and enable the action of the centrifugal pumps to be graduated exactly to the required service, a requirement which could not have been filled had it been attempted to use the curb enclosing the boulder directly for a suction sump.

The work was completed and the wall finished in about 7 months under the direction of Mr. A. McC. Parker, assistant engineer.

The Big Cottonwood Conduit of the Salt Lake City Water Supply.

The water supply of Salt Lake City is secured from Utah Lake and a number of creeks in the mountains near the city. The flow of the creeks is conserved in reservoirs from which the water is fed to the city mains by large pipes and conduits. The latest extension, the Big Cottonwood conduit, leads the water from the creek of the same name to a reservoir previously built in Parley's Canyon. The construction of the conduit was started in September, 1905, completed during the latter part of last year, and put into service on Feb. 5, 1907. It is a reinforced concrete structure 38,167 ft., or about 7¼ miles long, and has a capacity of 32,000,000 gal. in 24 hr.

Two different sections have been used for the conduit, the one first adopted being rectangular and the second, which was substituted about 5 months after the work had started, has an arched instead of a flat roof. Both sections are 3½ ft. wide. The rectangular section is 4 ft. high with a depression of 2 in. at the center of the floor, the thickness of the latter being 8 in. at the side and 6 in. in the center. The side walls are 6 in. thick, and the flat roof from 4 to 6 in. according to the depth of cut in which the conduit was constructed. In the arched section the floor is the same as in the rectangular type, except that the corners were rounded to prevent the lodgment of impurities, but the side walls were increased to 8 in. in thickness and the roof to 6 in. at the center. The rise of the arch roof is 10.3 in. Of the total length of the conduit, about 27,000 ft. have the section last described.

The reinforcement consists of ⅜ and ½-in. twisted steel bars imbedded in the concrete in planes at right angles to the axis of the tunnel and spaced 6 to 9 in. on centers. In a number of places the conduit is built on piers above the level of the ground, and in such cases additional reinforcement is provided by rods laid longitudinally.

The inside of the conduit is plastered with a coat of cement grout composed of equal parts of cement and sand, and all exposed stretches of the conduit are covered with at least 2 ft. of earth. Blow-off valves with mud drums are provided at three convenient points along the line so as to allow the conduit to be drained for cleaning or in case of emergency.

In building the conduit, as soon as a sufficient length of line to be served economically by one concrete mixer had been graded, the forms for the bottom and walls were erected, and on them, supported by the bracing across the top, was laid a narrow-gauge track on which were operated the steel cars carrying the concrete. The mixing plants were located at suitable intervals in places which could be conveniently reached for delivering the materials and were installed immediately alongside of or over the line of the conduit so as to be able to discharge by gravity into the steel cars. Wooden forms were used exclusively on the work, the lagging for the inside of the conduit being of dressed and matched lumber.

The head of the conduit in Big Cottonwood Creek is in the concrete diversion dam which has been thrown across the canyon so as to create a storage reservoir. From this point it follows the side hills along the hydraulic gradient, through a rough country where considerable rock excavation was necessary, and finally empties into Parley's Canyon reservoir.

The cost of the conduit was $376,600 and about $23,000 more was expended on the dam and headworks and on the improvements to the Parley's Canyon reservoir. The work was done by contract by Mr. P. J. Moran under the supervision of Mr. Lewis C. Kelsey, city engineer.

Heavy Columns in the Metropolitan Tower, New York.

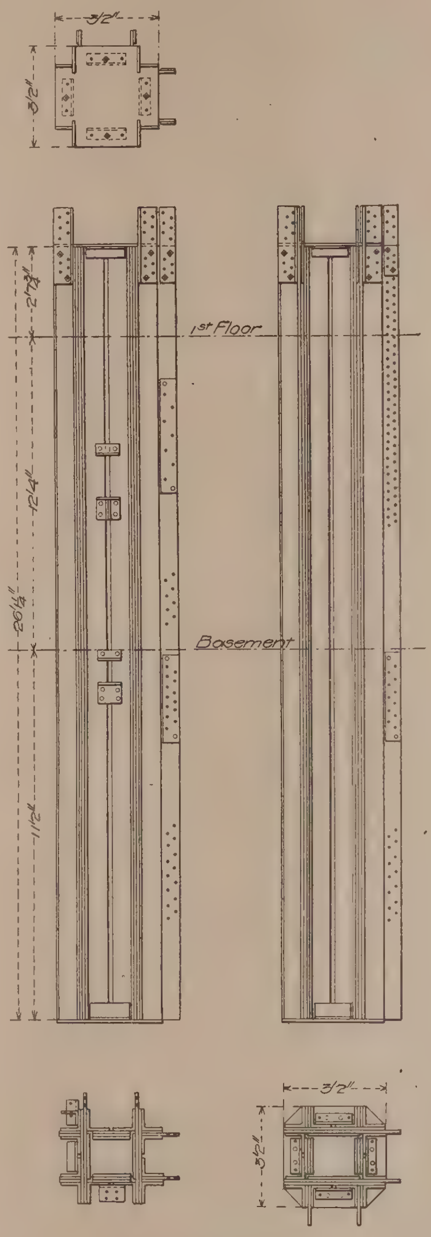
The great tower now under construction in this city for the home office building of the Metropolitan Life Insurance Company will be, as noted in recent articles in The Engineering Record, a 75x85-ft. rectangular steel cage structure with the unprecedented height of 668 ft. above the sidewalk and over 690 ft. above its foundation on the side lot. The exterior walls are of white marble lined with brick, and the floors are of concrete construction. As the lateral dimensions on the tower are equal to those of many tall office buildings and its height is fully three times as great, the static load alone is enormous, and when augmented by the loads from a wind pressure assumed at 30 lb. per square foot of the exposed surface of the tower, the combination results in stresses so large as to be almost or quite unprecedented in this class of construction and to require very special and interesting treatment in the design of the cross-section, details and connections of the principal columns.

The columns are arranged, as illustrated in The Engineering Record of February 9, in four transverse rows about 20 and 25 ft. apart. All of the 12-wall columns are connected by massive rigid sections of deep double girders and knee-braces forming a framework which substantially corresponds to heavy vertical trusses on each of the four faces of the tower, reaching from the foundation to the 38th floor where the roof commences. The corner columns thus receive double increments of wind loads, which give them, in the lower stories, maximum stresses of 7,500,000 lb. each.

The allowed unit stress reduced by the proper formula to nearly 14,000 lb. per square inch requires for these columns a cross-sectional area of 544 sq. in., which is provided as shown in the accompanying detail by twelve 8x8x1-in. flange angles and twenty 1-in. full length plates, two of them 44 in. wide; two, 38 in.; two 20-in.; eight, 14-in.; and six, 8-in. wide. The plates are so arranged as to form continuous webs projecting beyond the flange angles on two sides of the columns to provide connections for the wall girders and knee-braces and receive the wind stresses and distribute them throughout the columns without the use of detached plates, thus very much simplifying the column details and insuring direct and efficient transmission of stresses. A considerable economy is also effected by the almost entire absence of gussets, angles, etc., reducing the estimated weight of the columns to about 1,980 lb. per lin. ft., an amount scarcely in excess of that due to the effective cross-section. It is sufficient, however, to bring up the weight of a single one-story section to the very respectable amount of 26 tons.

Each column has a 38x38-in. base plate 1-in. thick seated on a cast steel pedestal, 7 ft. sq. and 3 ft. high, which weighs about 11 tons and distributes the load through an I-beam grillage embedded in concrete on the solid rock. The upper end of the column has a horizontal cap plate ¾ in. thick and receives the foot of the second-story column which is connected to it with eight ½-in. splice plates 5½ in. and 6½ in. in width which are field riveted to both members and serve only to maintain them in accurate alignment until they receive a portion of the dead load, which is, of course, entirely transmitted to the carefully milled butt joints.

The intermediate wall columns although receiving somewhat lighter wind loads carry heavier floor loads and thus require cross-sections only a little inferior to those of the corner columns. Columns 7 and 14 in the first and second stories are 38 ft. 3¼ in. long, have a cross-sectional area of 416 sq. in. and a total estimated weight of 57,493 lb., equal to about 1,500 lb. per lin. ft. They have an ordinary rectangular closed cross-section made with three webs and two cover plates, all of them heavily reinforced and built up with eight 6x4x1-in. flange angles, eight 22x1-in. web plates and six 28x1-in. cover plates, all full length. The connections for wall girders and knee braces are on opposite sides and instead of being formed by extensions of the continuous pieces forming the column sections are made with pairs of 8x6x½-in. angles and 6x6x½-in. angles from 7 to 8 ft. long, four pairs of angles in each set.

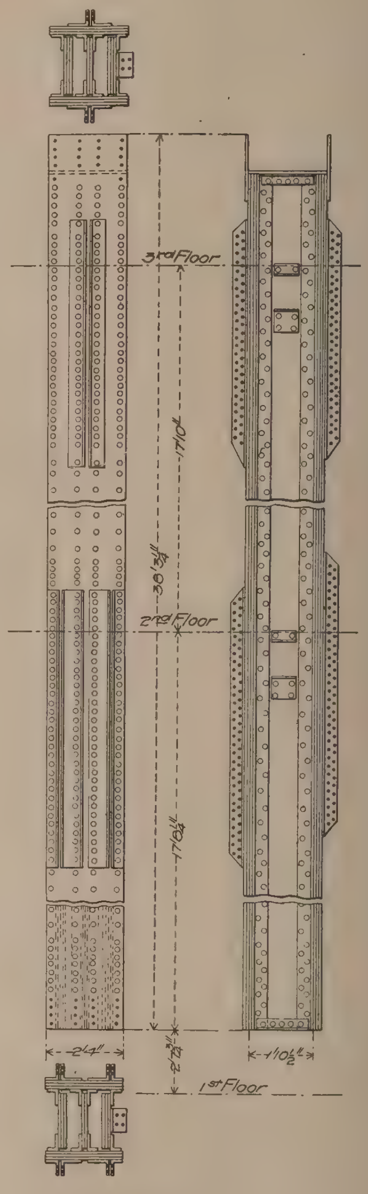


Corner Column.

The columns have horizontal cap plates at the upper end and the splices are very simply made with pairs of short cover plates shop riveted to the upper ends of the lower sections of the columns and field riveted to the lower ends of the upper sections. The connections for each of the twin wall girders in the lower story are made with fifty-two 1-in. rivets in double shear. Sub-punching and reaming is permitted only in material less than ¾ in. thick, and as all of the principal parts of these columns are made from thicker materials the rivet holes are drilled from the solid metal, thus making an unusually large amount of shop work, but insuring very perfect work.

In the upper part of the tower the dimensions of the columns diminish to 42x42-in. at the fifth floor, 38x38-in. at the 12th floor, 36x36 in. at the 18th floor, 32x32 in. at the 20th floor, 19x29 in. at the 25th floor, 18x28 in. at the 28th floor, 20x24 in. at the 33rd floor, and 12 in. at the 37th floor. Most of them are shop riveted in two sections with an average length of 24 ft. above the 12th floor, below which the stories have heights of 13 to 20 ft.

The weights of even the lighter columns are therefore considerable, as is indicated on the special weight diagram provided for the erectors and showing the maximum loads to be hoisted at different levels. The heaviest columns are at the 3rd floor and are 39 ft. long and weigh 29 tons each. At the first floor there are 25-ft. 25-ton columns; at the 12th floor, 151 ft. above the sidewalk, 29-ft. 19-ton columns; at the 19th floor, 14-ton columns, and 33rd floor, 48-ft. columns weighing 8 tons each, which have to be hoisted over 400 ft. above the sidewalk. There are besides a number of heavy girders including 48 plate girders 78 ft. long, weighing 11 tons each at a height of 441 ft. above the sidewalk and shorter 4½-ton girders 491 ft. high; the highest heavy pieces are the 24-in. I-beams 13 ft. long over 600 ft. above the sidewalk.



Intermediate Column.

Mr. N. LeBrun & Sons are the architects, Purdy & Henderson the consulting engineers, and Post & McCord, the contractors for the fabrication and erection of the steel work.

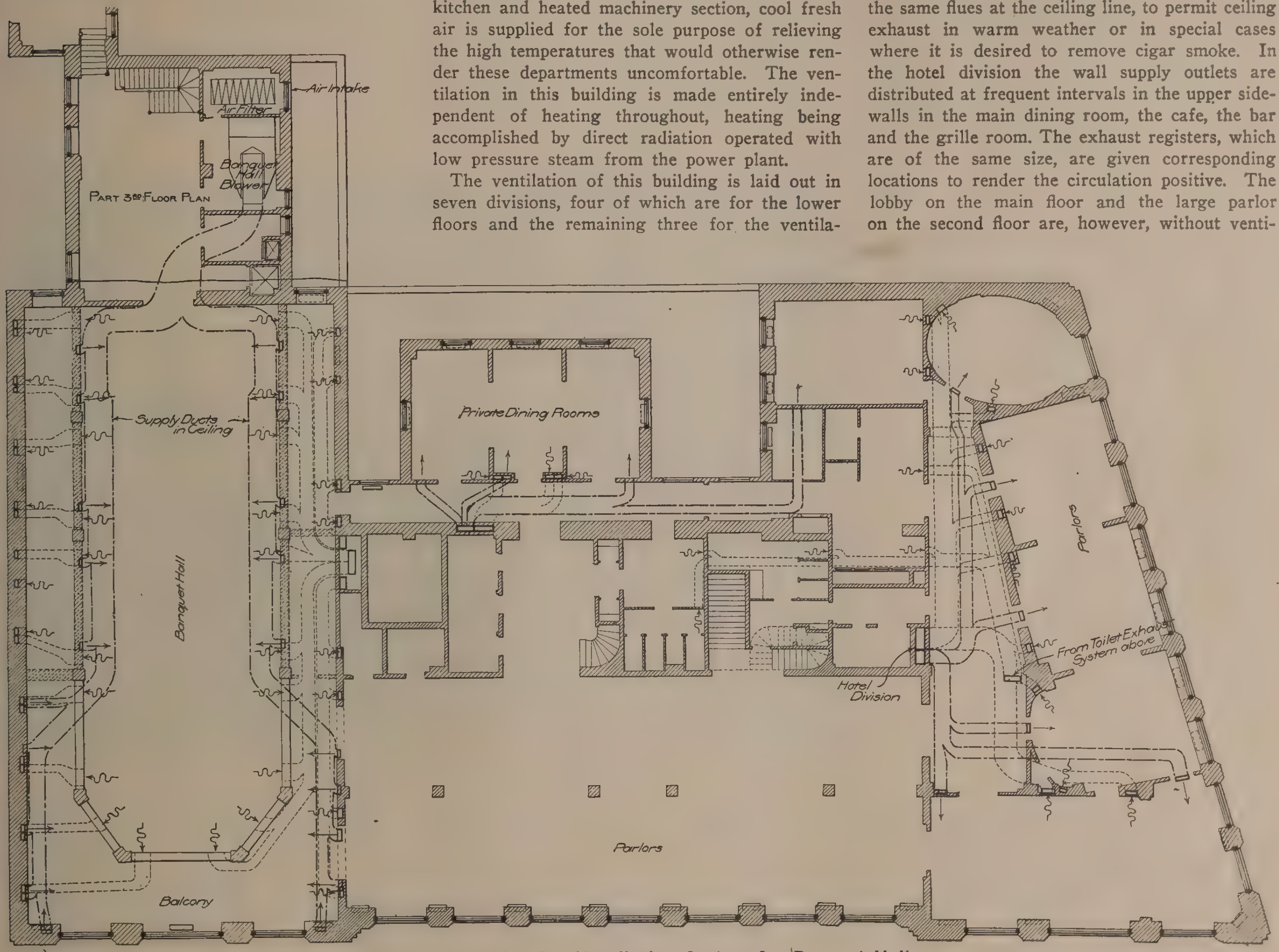
Heating and Ventilating the Hotel Knickerbocker, New York City.

The Hotel Knickerbocker, which was opened to the public early in 1907, is the most recent and one of the finest appointed of the transient hotels in New York City. It is a 12-story fireproof structure occupying an irregular corner plot, fronting 110 ft. on Broadway, 180 ft. on 42d St., and extending through the block at the rear corner to 41st St., with 50 ft. frontage on the latter street. It has, on the main floor, the hotel lobby, cafe and dining room, on the second floor parlors, private dining rooms and a banquet hall, and guest rooms from the third to the eleventh floors inclusive, with employees' dormitories on the 12th floor and ventilating apparatus in pent houses on the roof. The basement is devoted to kitchen and serving rooms, and a grill room, while all mechanical apparatus is accommodated in a spacious sub-basement, which also contains storage rooms and the laundry. Both the basement and sub-basement extend under the sidewalk, except where this is prevented on the 42d St. side by the underground structure of the New York Subway.

The mechanical equipment of this hotel is unuslly complete, embracing an extensive power plant with the usual service auxiliaries, and a very complete installation for the ventilation of the lower and sub-surface floors as well as all toilets and baths on upper floors. The particularly open location of the hotel facing directly on Times Square, with window exposure on practically all four sides, obviated the necessity of ventilation in the guests' rooms on the upper floors. All of the bath rooms that have not exterior windows are, however, fitted for exhaust ventilation, air being admitted to such rooms through louvres in the doors. On the second floor, however, there is a large banquet room, which, together with a number of smaller private dining rooms, are amply fitted for ventilation, both fresh air supply and exhaust, and similarly all the public rooms on the lower floors are well ventilated. The purpose of the ventilating equipment has been to provide ample changes of air throughout, for maximum conditions of occupancy in all of the public portions, while in the kitchen and heated machinery section, cool fresh air is supplied for the sole purpose of relieving the high temperatures that would otherwise render these departments uncomfortable. The ventilation in this building is made entirely independent of heating throughout, heating being accomplished by direct radiation operated with low pressure steam from the power plant.

The ventilation of this building is laid out in seven divisions, four of which are for the lower floors and the remaining three for the ventilation of the baths on the guest-room floors and auxiliary rooms. The four lower divisions include what is known as the hotel system, covering the grill room in the basement, the entire first floor and the parlors on the second floor; the banquet hall system; the kitchen and laundry system, and the engine room system. It was found advisable to separate the banquet hall system from that first mentioned, called the hotel system, owing to the fact that the banquet hall is used at infrequent intervals only, and when in use requires a comparatively large ventilating capacity. The kitchen and laundry and engine room systems are operated separately owing to the fact that in the former a considerable amount of air tempering is required under winter weather conditions while in the latter cold fresh air only is supplied at all times, there being no need for warming in the heated machinery section of the sub-basement. The fans for all of the systems for the four lower divisions are located in the sub-basement, with the exception of the supply fan for the banquet hall system which, for convenience of air intake and distribution connections, was located on the third floor. The toilet exhaust systems have disc exhaust fans located in the usual arrangement on the roof of the building and draw through vent flues which connect in the various sections of the building with the bath rooms and toilets to be ventilated.

The ventilation is generally applied in the public portions on the downward system, the fresh air being supplied through outlets near the ceiling in all cases, with exhaust through registers near the floor. The floor exhaust registers are, however, duplicated throughout by registers from the same flues at the ceiling line, to permit ceiling exhaust in warm weather or in special cases where it is desired to remove cigar smoke. In the hotel division the wall supply outlets are distributed at frequent intervals in the upper sidewalls in the main dining room, the cafe, the bar and the grille room. The exhaust registers, which are of the same size, are given corresponding locations to render the circulation positive. The lobby on the main floor and the large parlor on the second floor are, however, without ventilation connections, the entrances from out-of-doors and the numerous connections with the corridors and other adjacent rooms providing sufficient ventilation for all practical purposes. An extension of this system is made in portions of the second floor to a number of smaller parlors, private dining rooms and special rooms, to each of which there are individual supply and exhaust connections, as shown on the accompanying second floor plan; these connections are, it should be stated, independent of the toilet and locker room exhaust systems which are also shown on this plan, the latter being operated by a flue connection from one of the roof exhaust fans. The private dining rooms consist of a group of three connecting 11x20-ft. rooms fitted with independent supply and exhaust connections on the above arrangement, by which uniform rates of ventilation are insured in each under all conditions. The capacities of air supply and the exhaust apparatus which are provided for this hotel division are almost exactly



Second Floor Plan Showing Ventilating System for Banquet Hall.

Fan Equipment in the Hotel Knickerbocker.

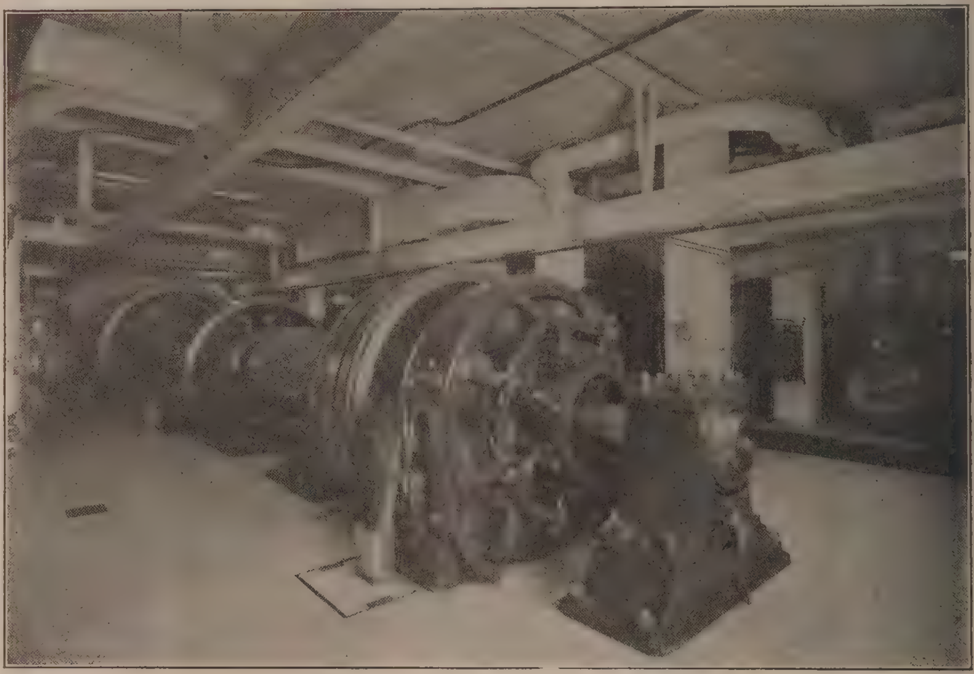
		Size of Fan.	Wheel Width.	Speed.	Capacity per Min.	Size of Motor, H.P.
Hotel division	Supply	9 ft.	5 ft.	130 r.p.m.	44,900 cu. ft.	18
	Exhaust	9 "	4½ "	130 "	40,400 "	15
Banquet hall division	Supply	5½ "	3 "	150 "	11,450 "	4
	Exhaust	7 "	4 "	150 "	26,000 "	8
Kitchen and laundry division	Supply	6½ "	3½ "	220 "	27,980 "	15
	Exhaust	9½ "	6 "	123 "	56,000 "	25
Engine room division	Supply	5½ "	3 "	213 "	16,200 "	7
	Exhaust	8 "	4 "	147 "	31,800 "	12
Bath room division	Exhaust	2—60 in.	....	300 "	48,000 "	4½
Annex	Exhaust	1—42 "	....	450 "	13,000 "	3

equal, the supply being a trifle in excess of that for exhaust.

The banquet hall is a room 47x93 ft. in plan, occupying the entire easterly end of the second and third floors. It has a balcony on the third floor level at the forward end, narrowing at the rear on this level to a width of 29 ft. for a distance of 57 ft. The arrangement of ventilation in this division consists of fresh air supply from 10 registers near the third floor ceiling line which are arranged as shown in the accompanying plan and exhaust connections at the edge of the gallery on the third floor level and also under the gallery in the sidewalls near the second floor level. The arrangements of registers were carefully studied for proper distribution of ventilation under extreme conditions of occupancy in the hall, it being made possible to remove air in large volumes at the balcony level and thus prevent the disagreeable accumulation of cigar smoke. The distributing ducts for the ceiling fresh air supply outlets are arranged above the main ceiling of the hall, connecting at the rear to the supply fan which is located on the third floor level. The exhaust registers are operated by independent duct connections to the sub-basement, where dampers are provided to enable either the top or bottom registers to be operated independently or together as required by conditions in the hall. For this hall, comparatively great ventilating capacity has been provided to permit of ample ventilation in times of extreme occupancy. The capacity of exhaust is also made considerably in excess of that for supply, the purpose being to cause a state of plenum inward and thus prevent the communication of cigar smoke or odors to the hall or corridors of the hotel.

The kitchen and laundry system involves the simple arrangement of supply and exhaust fans in the sub-basement with short direct connections to the kitchen directly above, and the laundry at the forward end of the sub-basement. The arrangements of supply and exhaust outlets in the kitchen follow the usual arrangement, consisting of numerous vent openings over the ranges, stock boilers, and other cooking utensils and cool fresh air outlets at the rear of the positions occupied by the cooks, to permit of a blast of cool air from the rear when at work. The bakery, pastry and dish-washing departments are also similarly equipped with ample ventilating connections, and owing to the heated condition of these departments all exhaust registers are located at the ceiling line. The ventilating connections in the laundry follow also this latter arrangement, the arrangement of connections differing principally in this department in that large gathering hoods are located over some of the mangles and other washing apparatus from which large volumes of steam are emitted; this tends to keep the laundry atmosphere clear and prevents the communication of steam to the corridors of the building. In this division the exhaust capacity is, of course, made considerably in excess of that for fresh air supply, for the purpose of creating a strong plenum inward, and thus preventing the communication of odors from either department into other portions of the building. Similar to this system in all its details is the engine room ventilating division, which involves fresh air supply and exhaust in all portions of the heated machinery section. The fresh air is supplied without tempering and the capacity of exhaust is also considerably greater than that for the fresh air supply for the same reason as in the case of the preceding division.

For exhaust ventilation from the baths and toilets on the guest floors there are two vent risers, each with groups of gathering ducts from the various rooms, which are located at the front and rear corners of the building on the 42d St. side. These systems are installed solely for the ventilation of baths and toilets which have no opening to outside air; such bath rooms as have outside windows are not thus equipped. The general arrangement is shown in the accompanying second floor plan, that in the front corner exhausting in general from nine bath rooms on each of the floors and that at the rear similarly from eight baths; the smaller flue shown in the central portion serves to exhaust from groups of two inside baths on each of the floors, as far down as the fourth floor, being connected at the top to the rear corner riser. These two larger vent flues are operated by 60-in. Howard & Morse disc fans which are located in pent houses on the roof and discharge directly to the atmosphere. These fans are vertically arranged for economy of space, and are each driven by a 4½-h.-p. round type vertical shaft Sprague electric motor. The third exhaust system consists of a 42-in. disc fan of similar make, direct driven by a 3-h.-p. round type Sprague vertical motor, which is located on the roof of the annex and exhausts from the servants' dining rooms and a number of auxiliary rooms in the annex.

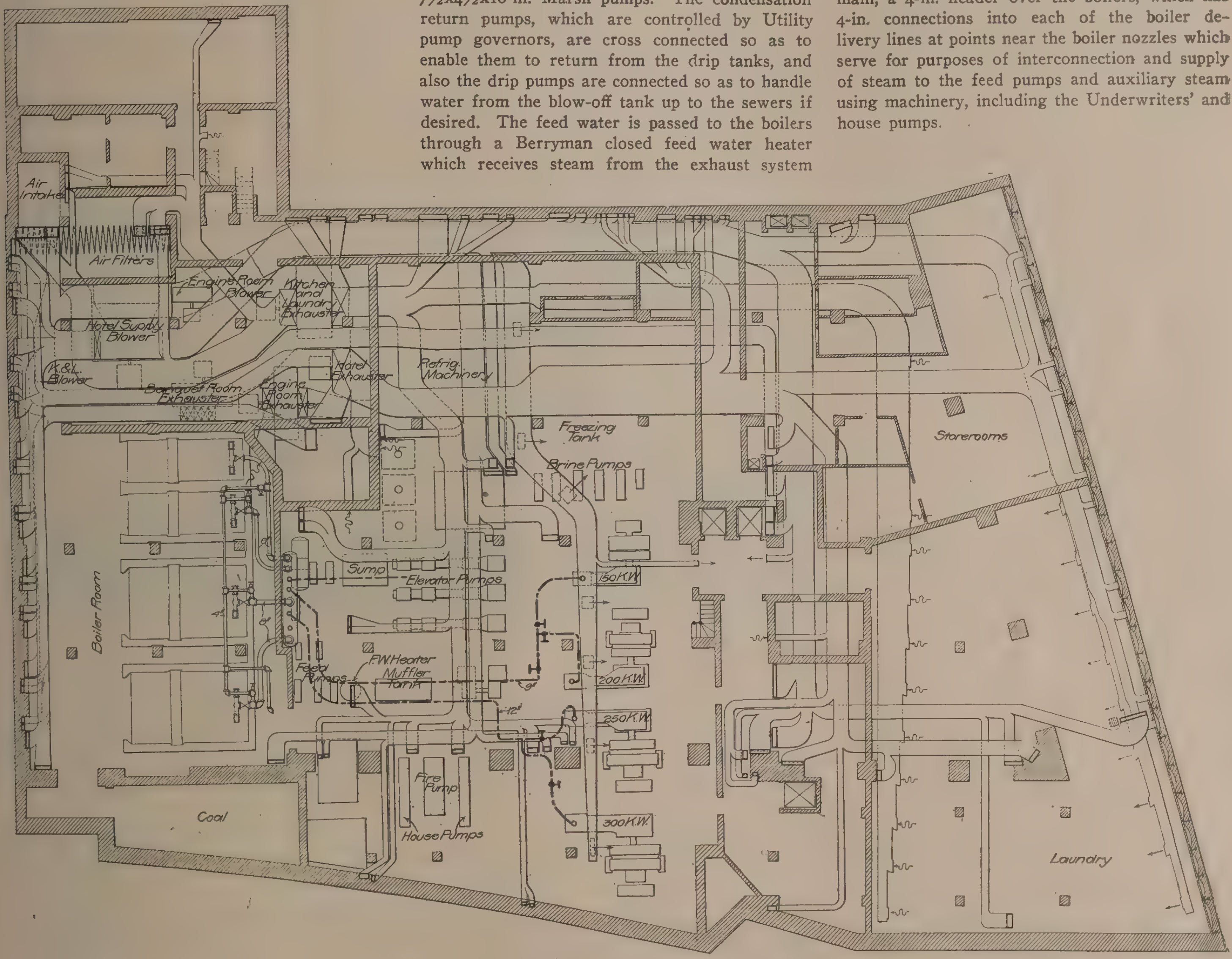


Electrical Generating Units in Engine Room.

The fans operating the four ventilating divisions in the lower portion of the building, of which there are seven in the fan room in the basement and one on the third floor at the rear of the banquet hall, are all Sturtevant steel-plate centrifugal fans, which have been installed in the following sizes (see appended table for list of dimensions and capacities.) These fans have intake through a filter chamber with 8 x 10-ft. shaft connecting to a ventilation court on the 2nd floor level, the filters being of the usual zig-zag cheese cloth type, designed for low filtering velocities. The motors operating these fans are all of the type D Sprague direct-current motors which are equipped with variable speed starting boxes by means of which considerable changes of speed may be obtained. The motors are operated at 110 volts, each on separate power circuits from the switchboard. The duct connections are all of rectangular iron construction and are well arranged in the sub-basement for the complexity of equipment involved. They are heavily covered with asbestos air-cell coverings, protected with canvas sewed on.

The building is heated throughout by direct radiation, utilizing low pressure exhaust steam from the steam using machinery of the power plant with the Paul system of returns. Automatic temperature regulation is provided upon radiation in practically all of the public portions of the buildings, but that in the guests' rooms is fitted for hand control. The distribution of radiation follows the usual plan of units underneath window-sills in varying capacities to correspond with the amount of glass exposure to be counteracted and in all public and guest rooms, radiators are enclosed in recessed spaces with ornamental grilled fronts. Steam is supplied to the radiation on the one-pipe system through risers located in chases in the sidewall construction, which are fed by a distributing main on the sub-basement ceiling. The distributing main consists of a 12-in. line connecting with the muffler tank of the exhaust steam system of the power plant which extends to the front of the building reducing to 7 and 6 in. to supply the risers, and full size to the rear, supplying both risers and tempering coils of the fresh air supply fan systems in the fan room at the rear corner of the basement.

The power plant and mechanical equipment of the hotel occupies about two-thirds of the sub-basement space, the remaining third of the sub-basement at the Broadway end being devoted to a 60x70-ft. laundry and a number of store rooms for hotel supplies. The power plant section consists of a 43x60-ft. boiler room at the rear on the 42nd St. side with 12-ft. coal bunker extension under the sidewalk, a 40x60-ft. fan room and in the central portion, the main engine and machinery room, which is 75 ft. in width and extends entirely across the building, a distance of 120 ft. Ample head-room is provided in practically all sections of the sub-basement for overhead piping and duct connections, that in the engine room permitting a traveling crane runway over the electric generating machinery for handling of parts. A feature of this mechanical plant installation is the care that has been given to the appearance of the interior, the floors being finished in tile throughout the machinery and laundry section, all piping and duct work being conveniently and orderly arranged and the interior attractively finished throughout.



Details of Ventilating Equipment in Sub-Basement.

Steam is generated in an equipment of four Babcock & Wilcox water-tube boilers which have an aggregate capacity of 1,400 h.-p. These consist of two small units set in a single battery and two larger units each in single settings, the smaller units having 120 and the larger units 210 four-in. tubes 18 ft. in length. They each have 42-in. steam drums, 18 ft. in length for the smaller units and 14 ft. for the larger ones, and are designed for a working pressure of 125 lb. The settings are equipped with Thompson shaking grates for hand firing, the coal consumption under ordinary conditions of operation being about 28 tons per day. Coal is stored in a 200-ton bunker, under the sidewalk at the 42nd St. end of the boiler room, into which it is dumped directly from the street. The coal is handled to the furnaces by a bucket and chain industrial trolley, installed by the Northern Engineering Co., of Detroit, Mich., the buckets having a capacity of 500 lb. each. The ashes are handled by the same trolley system, being delivered to a small ash hoist near the coal-bunker which raises the ashes in cans to the street level.

Boiler feeding is provided for by an equipment of eight pumps, flexibly arranged in four groups of duplicated units, four of which return condensation from the heating system, two of the remainder handling water from the high or low pressure drip tank and the two others for the make-up water from the city water supply. The condensation return pumps are 10x6x12-in. Marsh duplex steam pumps, while the other four are 7½x4½x10-in. Marsh pumps. The condensation return pumps, which are controlled by Utility pump governors, are cross connected so as to enable them to return from the drip tanks, and also the drip pumps are connected so as to handle water from the blow-off tank up to the sewers if desired. The feed water is passed to the boilers through a Berryman closed feed water heater which receives steam from the exhaust system of the plant and preheats the feed water to about 200° Fahr. The blow-off system involves a 4x8-ft. steel plate tank in the machinery room at the rear of the boiler fittings, to which 2-in. blow-off connections are made from the boilers. A Utility pump governor connected to this tank controls the blow-off pump to keep the tank half filled, discharging the blow-off from the boilers to the sewers as it accumulates.

The steam piping of the power plant embraces an unusual arrangement of individual connections from the boiler nozzles to a large steel plate drum or header on the engine room side of the division wall, from which drum the high pressure delivery connections are made. The drum is 30 in. in diameter by 15½ ft. long and has 6-in. connections to the smaller boiler units and 8-in. connections to the larger ones, each connection having a gate valve at the drum and a Bedford non-return stop valve at the boiler nozzle. The main delivery connections consist of a 9 and a 12-in. line to the engine room, the former supplying a 150-kw. and a 200-kw. generating unit and the latter a 250-kw. and a 300-kw. generating unit, all through Cochrane steam separators; an 8-in. line delivers steam to the elevator pumps, the refrigerating compressors, brine pumps, etc., a 3-in. line through a pressure reducing valve to the laundry and kitchens, and a 6-in. delivery line through a 6x12-in. reducing valve to the heating supply mains for make-up to supplement the exhaust steam in case of deficiency. There is in addition an auxiliary main, a 4-in. header over the boilers, which has 4-in. connections into each of the boiler delivery lines at points near the boiler nozzles which serve for purposes of interconnection and supply of steam to the feed pumps and auxiliary steam using machinery, including the Underwriters' and house pumps.

The electrical generating equipment consists of four Sprague multipolar engine-type generators direct-connected to Fleming four-valve engines. These units have been installed in a novel arrangement of sizes, their capacities being 150, 200, 250 and 300 kw. respectively, in order to permit of adjusting the generating capacity as close as possible to the current consumption in the hotel at all times. The units are located in an engine room of more than usual beauty, each being guarded by a 2-in. polished brass railing and the flywheel shrouded by a Russia iron casing. The room is spanned by a 10-ton hand-operated traveling crane supplied by the Northern Engineering Co. The engineer's office is located in a mezzanine gallery at the westerly side, from which position a clear view is had of the entire engine and machinery rooms.

The generators deliver current at 110 volts, direct current, the hotel being wired on the 2-wire system. The circuits are controlled on a large switchboard in front of the generators, which is divided into two sections for power and lighting service. All motors are operated on individual circuits from the power sections and on the lighting section, there are 42 feeders of capacity from 100 to 800 amperes. The average running load carried by the generating machinery is 3,000 amperes.

The elevator equipment of the hotel consists of 11 passenger elevators installed by the Standard Plunger Elevator Co., of New York, which are operated by three 18 and 28x13x24-in. American compound single cylinder pumps of the outside center packed plunger type. These units have each a capacity of 650 gal. of water per min. against a pressure of 160 lb., being installed in the three-unit layout to permit of one pump carrying the load when the service is light, and not requiring over two pumps under any circumstances, so that one unit is always held in reserve. There are three pressure tanks, consisting of 6x22-in. steel plate tanks suspended on the ceiling over the pumps, in which air space is maintained by a 10x8 and 4x12-in. two-stage Marsh air compressor. The elevator discharge tank has a capacity of 15,000 gal.

The refrigerating plant consists of two 45-ton and one 3-ton machines of the ammonia compressor type which were built by the York Mfg. Co. Either one of the 45-ton machines will handle the entire refrigeration duty in the hotel and the 3-ton machine is for very low temperatures for making ice-cream, etc. About 9 tons of ice is manufactured daily, and the total refrigerating duty averages about 45 tons per day. All cooling service in the hotel is operated by brine circulation, for which there are two services, one for the upper portion of the building and the other for the lower. The upper or high pressure circulation is operated by 7½x4½x10-in. single cylinder Marsh pump in duplicate while the low pressure service is operated by three 10x8x12-in. American pumps. A separate system is used for ice manufacturing, a 4x6x8-in. Marsh pump circulating the brine to the ice tank. Other auxiliary services operated include extensive vacuum sweeping and pneumatic tube systems, and an electrically operated printing establishment in the annex, in addition to which large amounts of live steam are used in the laundry and kitchen apparatus.

The mechanical plant of the hotel was designed by G. A. Suter & Co., New York, in consultation with Mr. Alfred R. Wolff, consulting engineer, New York. The steam generating, heating and ventilating equipment were installed by G. A. Suter & Co., the generating machinery by G. E. & A. L. Pennock, and the wiring by the Lord Electric Co., New York. The architects of the building were Trowbridge & Livingston.

Automatic Coaling Barges of the American elevator type have recently been introduced on the Mersey in England, five such barges of 1,300 tons capacity each being operated there. They are fitted with elevated bins, which are filled from the barge below by continuous bucket conveyors, on the principle of the floating grain elevators, and thence discharged through adjustable chutes into the coal bunkers of the steamers. The coal delivered is automatically weighed and each barge can deliver at the rate of 180 tons per hour. In a recent test 904 tons of coal were placed on board of one of the English war vessels in 4¾ hr. by two of these barges, although if a sufficient number of workmen had been available for trimming the coal in the bunkers, this could, it is said, have been accomplished in 3½ hr.

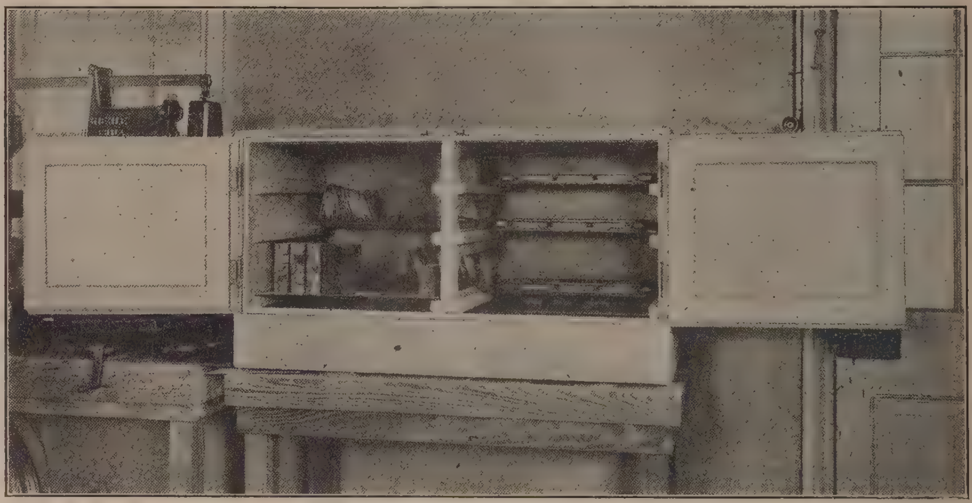
A Novel Moist Closet.

Read at the annual meeting of American Society for Testing Materials on June 22 by Mr. E. B. McCready, of the Lehigh Valley Testing Laboratory at Allentown, Pa.

A brief description of a moist closet—fully equal to a slate or soapstone closet—which may be made in any laboratory with a minimum of cost considering its character, may be of interest to some of the members of this society. The closet illustrated was made of "waste cement" left from a testing—all brands mixed—and several samples of natural sand from the same source. The cement was thoroughly mixed, as were the sand samples, so as to insure uniformity in color.

The mortar was mixed 1 to 2 and wet enough to be filled readily into and tamped down in a ⅝-in. space. The walls are 1¼ in. thick, except the center panels of the doors, which are only ½ in. thick. The walls are reinforced with ½-in. mesh galvanized wire netting.

The hinges in this closet were specially designed to be imbedded in the walls and doors.



Interior of Moist Chamber of Reinforced Concrete.

Of course, if desired, ordinary strap hinges can be used, except that they should not be of iron, and may be bolted to the doors and walls. The hinge shown is a little more expensive, but makes a better appearance.

The dimensions of this closet are practically the same as those of the soapstone closet described by Mr. R. L. Humphrey and illustrated by Taylor & Thompson and others, but shape and size may be varied to suit the space to be occupied or the size of molds used. The necessary forms can readily be made by any carpenter and consist of an outside form or box, without top or bottom, and two inside forms or cores, which are simply boxes with tops, but no bottoms. As the closet is cast face or front down, the top of the forms means the back of the closet. When the forms are in position, there must be 1¼-in. clearance all around each core, top, bottom and sides.

The doors are cast first by filling in a frame of the proper dimensions, laid on a pane of glass or other flat surface which has been oiled. The hinges are placed by marks on the frame and secured to it by small brads before the mortar is filled in. The same form answers for the two doors by simply reversing the position of the hinges. If made like those illustrated, the hinges must be "right" and "left."

When hard enough to stand handling, the two doors are placed, in their proper relation, face down, on a flat surface and the outer box-form placed around them. The edges of the doors are covered with several thicknesses of oiled paper and the cement mortar filled in around them level with the doors, making the layer of mortar just 1¼ in. thick. The inside forms are immediately placed in position, open end down, and are supported by the doors, which are sufficiently hard. If correctly made, they will reach to withiin 1¼ in. of the top of the outer form and there will be an open space of 1¼ in. all around each core. The mortar is then filled in around and over these cores and smoothed off even with the top edge of the outer form; this top layer forming the back of the closet.

Of course, the placing of the reinforcement adds slightly to the detail of these operations. The doors and the back are filled in two layers with the wire placed between. The wire for the sides, in one piece, is placed in position and kept in the middle by strips of half-inch board which are moved along or taken out as the mortar is filled in.

The doors may be panelled and their weight reduced by placing in the frame, before and after filling a piece of plate glass, slate or even wood of the desired shape and thickness. These are removed after the mortar has hardened.

The forms must be thoroughly shellacked and oiled before use. The cores must be put together with screws, entirely from the inside and exposed ends and edges slightly bevelled so that they may be removed after the cement has set.

The shelf cleats are provided for by longitudinal strips on the ends of the core boxes, in width equal to the distance desired between the cleats. The space between, when filled with mortar, makes the cleat.

The appearance of the closet may be enhanced by thoroughly moistening the green surface after the removal of the forces and sifting some neat cement lightly and evenly over the whole from a 50 or 80 mesh sieve.

This closet has been in use a little over a year and has given great satisfaction. It is watertight and requires no felt lining to maintain a uniform degree of humidity. By actual repeated tests, we have found the percentage of saturation on the top shelf to be as high and often a little higher,—owing, perhaps, to a slight difference in temperature,—than at the surface of the water.

The Pavements of Berlin have a total area of 7,499,600 sq. yd., of which 4,521,000 sq. yd. are stone, 2,857,300 sq. yd. are asphalt and 120,900 sq. yd. are wood, the remainder being slag, macadam and concrete. The stone blocks rest on an 8-in. bed of crushed stone and the asphalt on 8 in. of concrete. Natural asphalt 2 in. thick after compression is used.

The Hydro-Electric Plant of the Vancouver Power Co.

The Vancouver Power Co., Ltd., has for some years been operating a hydro-electric plant supplying current for electric lighting, street railways and commercial purposes in Vancouver, B. C., and the surrounding towns. The plant, which originally had a capacity of 9,000 h.-p., will eventually have a capacity of 30,000 to 40,000, the supply of water being ample for such a development. Measurements of the flow of three streams had been made for a number of years, but owing to the high cost of the first installation the work was not started for 10 years after the feasability of the project was determined. Construction was finally started in August, 1902, and current was first generated in December, 1903, though the plant was not completed until a year and a half later.

Early in 1902 a very careful examination was made of the water supplies which had been under observation, and as a result of the report rendered the plans which have since been executed were adopted. The scheme has been to build a dam across the outlet of Coquitlam Lake and bore a tunnel to Trout Lake, a distance of 12,775 ft., using the former lake for storage, and the latter as a balancing reservoir. The outlet of Trout Lake will likewise be closed with a dam, from which the pipe lines will lead to the power house, situated on an arm of the sea just above high tide.

The main source of supply, Coquitlam Lake, is a glacial lake having an area of 2,300 acres, situated 432 ft. above sea level. The drainage area is approximately 100 square miles, and the annual precipitation over it about 150 in. The smallest flow from the lake in thirteen years was 300 cu. ft. per second, and this continued for about fifteen days. Trout Lake is separated from Coquitlam by a mountain range, about 2½ miles across, rising 4,000 ft. above the lakes. The former lake is located 400 ft. above sea level, close to the north arm of Burrard Inlet, and 32 ft. lower than Coquitlam Lake. Its area is approximately 500 acres, and the storage capacity which can be drawn upon amounts to a depth of 16 ft. over this area. The attainment of very high peak loads is therefore possible without danger of a failure of the water supply.

The dam at the outlet of Coquitlam Lake is a rock-filled timber crib structure 113 ft. long, 14 ft. high, 12 ft. wide at the top and 50 ft. at the base. Below the dam is a very heavy timber apron, and on each side of the river below are two smaller aprons for protecting the abutments. This extensive protection was required because in flood periods large logs up to 6 and 8 ft. in diameter are brought down by the river. All the timbers are 12 in. square, drift-bolted together. The foundation of the dam rests on glacial hard pan over which was a stratum containing large boulders. A trench was dug in the hard pan along the upstream face of the dam and a double row of timber sheeting driven in the trench and spiked to the heavy timbers of the dam, the trench being then refilled and the material well rammed. The sheeting covering the dam consists of one thickness of 4-in. plank, over which is laid one thickness of 2-in. plank.

The tunnel connecting the two lakes is 12,775 ft. long, and has a normal section 9 x 9 ft., with rounded corners. The grade falls at the rate of 1 per cent. for the first 875 ft. from the Coquitlam portal, and from this point, where a drainage sump and pumping plant were located during construction, rises on a 0.02 per cent. grade for 5,600 ft. The last 6,300 ft. reaching to the Trout Lake portal is a down grade of 0.14 per cent. The tunnel intake in Coquitlam Lake consists of three submerged openings each 8 ft. square driven in the scolid rock, and leading to a cross heading 30 ft. back from the lake, where the 9x9-ft. section starts. This cross heading is 10 ft. square and about 36 ft. long normal to the tunnel axis. The three openings are protected from driftwood and debris by two lines of rock-filled timber cribs, supporting screens, the tops of which are at the level of extreme high water. Sixty feet back from the tunnel portals are two gates for controlling the flow of water. Each gate is 9 ft. high by 4½ ft. wide, built of structural steel shapes, and carries brass rollers, which run on I-beams forming part of the framework of the water tight bulkhead. The gates are operated by screw stems and hand wheels, and are worked from an operating tunnel above the main tunnel. The mountain is syenite or quartz syenite with occasional dykes of diorite, the latter being particularly hard and tough. No timbering was required.

The dam across the outlet of Trout Lake is a solid concrete structure, 361 ft. long, 54 ft. high above the base, with a top width of 7 ft. and a width on the base of 35 ft. It contains 10,000 cu. yd. of material, putting stones and 1:2½:5½ concrete, the stone in the latter being crushed granite. The mixture on the face for 18 in. is somewhat richer in order to secure water tightness. The foundation for the dam is a very sound syenite.

The openings of the pipe lines leading to the power house are steel pipes built into the dam, the tops of the pipes being 22 ft. below the crest. There are ten 54-in. and two 24-in. pipes, each fitted with a special brass-roller gate-valve at the face of the dam with a separate screen for each pipe. The intake gate-valves work in guides bolted to the face of the dam, and are fitted with brass rollers, on which the thrust due to the water pressure comes. A circular ridge on the back of the gate is machined to make the seat and a corresponding seat is made on the gate frame, to which the pipes are riveted. The gear for operating the gate is a simple screw stem and hand wheel, and the gates though quite tight can be operated with ease by one man at all stages of the water.

The total length of the pipe line is 1,800 ft., of which the upper 800 ft. are of wooden-stave construction, 54 in. in diameter, and the remainder of riveted steel varying in thickness from 9/32 to 17/32 in. and in diameter from 48 to 42 in. The exciter pipes are of steel throughout their entire length, and are 24 in. in diameter at the upper end and 18 in. at the lower end. Each pipe is fitted with air valves at three different points, a relief valve at the lower end, and a stand pipe just below the dam. The pipes are laid in a trench and covered with the excavated material, the top layer being of fine material in which clover was sown. At the lower end where curves occur the pipes are anchored to concrete piers from 12 to 16 ft. apart.

The power house, 40 ft. wide and 160 ft. long, is situated on an arm of Burrard Inlet, just above high tide. The main units, of which three were installed when the plant was constructed, have a capacity of 3,000 h.-p. each, and consist of a 2,300-volt Westinghouse generator, with two Pelton water wheels, one on each side of the generator. The water for each unit will be supplied by a separate pipe, a Y being inserted near the unit to conduct the water to the two wheels of each set. The head of water is about 400 ft.

The current is transmitted to Vancouver, a distance of 16 miles, at 23,000 volts. At Barnet the transmission lines cross a navigable arm of the harbor, the distance between supports being 2,750 ft. and the height of the conductors above high tide 150 ft. For the crossing twelve 7-strand 9/16-in. plow-steel cables are used as conductors.

The surveying and construction of the plant were quite interesting. Owing to the steep, rocky slopes and perpendicular cliffs of the mountains separating the two lakes, it was found impracticable to carry the levels over the range, and four lines of levels were therefore run from one proposed tunnel portal to the other, around the end of the range, a distance of 25 miles, the results having a maximum variation of 0.23 ft. A Buff transit having a large, high-power telescope was used for the alignment. Four transit stations were established, of which two were on the mountain 3,200 ft. apart, one on the further shore of Coquitlam Lake, and one on the further shore of Trout Lake. These latter stations were placed across the lakes from the tunnel portals because the latter could not be seen from the points on the mountain.

The tunnel was driven simultaneously from both ends, and hand drilling was used for the first 4 months when the installation of compressor and haulage plants was completed. The construction plants were furnished by the power company, but the work was done by contract on the percentage basis, the contractor's profits being increased in proportion to the decrease in the cost per foot from bidders' prices, and an independent bonus being offered for speedy completion. A 36-in. gauge railway was run from tide water to the Trout Lake portal, the first section having a length of 1,800 ft. and a rise of 400 ft. This portion was operated by a Lidgerwood hoist having a pull of 2,000 lb. The rest of the road is level, and the hauling is done by an electric locomotive. The plants at the portals consisted of a boiler supplying steam to an Armington & Simms high-speed engine, a 60-kw. d. c. 550-volt generator, supplying current for lights, ventilating motors and locomotives, and a Leyner two-stage air compressor, having a capacity of 400 cu. ft. of free air per minute. For the transportation to the Coquitlam portal it was necessary to build 2 miles of new road through dense forest and swamp, and to rebuild 7 miles of old road and bridges.

The full section of the tunnel was blasted out without driving an advance heading or drift. As soon after a blast as possible drilling was commenced for the next shot, the miners standing on the muck of the last blast and putting in the upper holes first. The muckers meanwhile removed the debris and then covered the floor of the tunnel for 30 ft. back from the face with ¼-in. iron plates about 4 ft. square. The iron plates afforded a suitable shoveling surface and greatly facilitated the speed of mucking.

The air for the drills was carried from the receiver, which had a capacity of 100 cu. ft., through a 4-in. pipe for half a mile from the portal, and through a 3-in. pipe the remainder of the distance. The temporary connections to the drills were made with 2-in. pipe. To overcome the trouble due to wet air, short drops were placed in the air line at half-mile intervals, and drip cocks on the pockets were left "cracked" to expel the condensed moisture. Flanged unions were provided at 500-ft. intervals to facilitate repairs and all joints were made up with oil and graphite. A number of different types of drills were used on the work, all operating at a pressure of 100 lb. per square inch. Four drills were constantly on hand at each end, two being in use and the other two in reserve.

The spoil cars were of special design, 30 in. high above the rails, with a capacity of 2 cu. yd. The bodies are of steel and swing on a centre king-bolt, dumping out of one end and on either side of the track. Each car weighs 1,500 lb., and cost $130. A General Electric locomotive with two 10-h.-p., 500-volt motors having a draw-bar pull of 1,200 lb. was used at each end. Each locomotive readily handled two loaded cars on a 6 per cent. grade. They were worked at a speed of 4 to 6 miles per hour.

Ventilation of the headings was provided through a 12-in. galvanized iron pipe of No. 24

gauge. Forty-inch Sturtevant fans driven by 5-h.-p. motors were placed at intervals of 2,000 ft., working in series, each fan forcing the air to the next one in the line. The speed of the fans was between 1,300 and 1,400 r.p.m. and cleared the tunnel of smoke and gas in 45 min. after a blast. In addition to this provision a stream of compressed air was blown into the heading through a quarter-inch orifice. Several methods of lighting the tunnel were tried, but were abandoned in favor af candles, which best fulfilled the miners' requirements. Temperature readings showed a rise of 2° Fahr. for each 1,000-ft. advance, the maximum temperature of 60° being found near the middle of the tunnel, and 3,500 ft. below the surface.

The work was begun at the Coquitlam portal by driving a working tunnel 5 ft. above the elevation of high water in the lake so as to guard against flooding the heading. This tunnel sloped downward on a 6 per cent. grade to meet the main tunnel. Thirty feet from the portal a shaft was sunk in the floor of the working tunnel to a depth of 18 ft., the bottom of the finished tunnel. From this shaft a cross heading was run at right angles to the tunnel axis, and from it three 8x8-ft. headings were driven backward toward the lake. During construction about 10 ft. of rock was left in place in the three headings to guard against flooding.

In building the Trout Lake dam a temporary cofferdam was built about 100 ft. upstream, and from it a flume 600 ft. long carried the flow of the creek past the site of the permanent structure. The earth excavated from the site was hoisted in skips by a derrick, dumped into the flume, and sluiced away, 20,000 cu. yd. being removed in this manner. The bedrock on which the dam rests was prepared for a good bond with the concrete by drilling it with 6-in. holes, 3 ft. apart, which were loaded and fired, thus producing a rough surface. The sand used for the concrete in the dam was dredged from the sea bottom near the mouth of Fraser River, pumped into scows, and after being towed to the landing was dumped into cars and hauled to the site. The sand, though not coarse, was very clean and sharp. Four brands of Portland cement were used on the work, White Bros., Hercules, Condor and Alsen.

In building the pipe lines a narrow gauge track was installed in the pipe trench for its whole length and operated by a steam hoist, all the materials for the pipes being brought to their proper place by means of it.

The wooden stave pipes were built by the Excelsior Wooden Pipe Co., San Francisco, at a cost of about $4 per lineal foot. The steel pipes cost approximately $14.50 per lineal foot, for the pipe alone. The cost of the grading for the pipe lines, including trench excavation, and back filling was $25,400.

The contractors were Ironside, Rannie & Campbell for the tunnel; Pelton Water Wheel Co., water wheels; Vancouver Engineering Works, steel pipe lines and head gates; Canadian Rand Drill Co., drills; and the Westinghouse Electric & Manufacturing Co., electrical equipment. Mr. Wynn Meredith was the consulting engineer, and Mr. E. B. Hermon, from whose article in the Transactions of the Engineering Society, University of Toronto, these notes have been taken, and Mr. H. M. Burwell, engineers in charge of construction.

The New Custom House in New York is not only one of the best examples of architecture in the city but it also seems likely to become famous for being completed considerably under the appropriations, which were $4,965,000 in all. While it is not yet completed, it is believed that when all bills are settled it will have cost under $4,900,000.

Sinking a Shaft Through Quicksand by the Pneumatic Process.

A mine shaft which presented unusual difficulties in its construction has recently been sunk by the pneumatic method on the Mesaba Range, near Biwabik, Minn., for the Syracuse Mining Co., to open up a rich deposit of iron ore. The ore body is adjacent to and extends under a lake of considerable size and immediately on top of the deposit is 45 ft. of quicksand. Owing to the proximity of the lake the ground is saturated with water. The mining company, realizing that the sinking would be difficult, arranged to use a patented method of sinking open shafts through water-bearing material and work was begun in December, 1904. The method adopted involved the driving of a series of cofferdams inside each other, the size decreasing with the depth.

Wooden sheet piles 18 ft. long were driven down around two sets of walling timbers, and the excavation was started. Very slow progress was made, owing to the heavy inflow of water and sand. The second set of piles was started, but a bed of large bowlders was encountered and piles could not be forced down. By this time four No. 10 Cameron pumps could not handle the inflow of sand and water. After a four months' trial the mining company decided to stop all operations at this point and shift the location of the shaft about 200 ft. south, where the overburden is perhaps 50 ft. greater, but the chance of encountering howlders was considered much less.

The permanent mining plant which had already been installed was accordingly moved at considerable expense up a steep hill to the new site. Here the company sunk a large timber shaft with its own force to the quicksand, about 50 ft., by the method commonly employed on the Mesaba Range. Rings of timber are suspended from the surface about 3 ft. apart. As the excavation proceeds 2x10-in. plank, 4 ft. long, are slipped in back of these timbers, forming a comparatively tight wall to keep out the soil. Each course of waling timbers, or "set", as it is locally called, is suspended from the set immediately above it by 1¼-in. bolts, the uppermost set being connected in a like manner to large round bearing timbers on the surface, spanning the excavation and carrying the weight of the shaft lining until the bottom is reached. As it was intended to drive steel sheet piling to the ledge through the quicksand, the shaft was accordingly made large enough to accommodate a steel sheet pile cofferdam at the bottom of and inside the timber lining.

Driving the steel sheet piling was begun in November, 1905, and continued until the following spring. The piles were driven by an ordinary derrick pile driver which rested on the timbers at the surface, a specially designed follower being used. A 3,000-lb. hammer was used and at one period of the work a water jet was also employed. The piles were very heavy in section and were driven very hard.

After the pile cofferdam was completed, a No. 10 Cameron pump was installed and the excavation started inside the steel piling, waling pieces and struts being introduced about every 3 ft. as the work progressed, to keep the piles in place. The excavating was accomplished without much difficulty to a point about 20 ft. below the top of the piles, but below this point it proceeded very slowly. After a few feet of material had been taken out the quicksand would suddenly begin to boil up from the bottom, a corresponding movement of the material on the outside of the shaft occurring at the same time. This badly distorted and cracked the shaft timbers.

It became evident that there was a bad leak or break in the steel sheet piling. Accordingly a crib of 10x10-in. timbers, 3 ft. high, was built at the bottom of the excavation inside the shaft, the intention being to load this crib and force it down till it overlapped the leak or break in the piling. It was hoped that the inflow could thus be checked. After the crib was forced down a few feet it stuck and very little was gained by the scheme. In the meantime each period of excavation was followed by an upward boiling of the quicksand at the bottom. The material around the outside of the shaft settled away, leaving the upper part of the lining exposed. Hay and straw were placed outside the shaft in the hope that at each settlement of the sand, this material would be carried down outside the steel piling and ultimately stop the leak.

At this stage it became necessary to support the timber shaft, which had broken away from the bearing timbers at the surface and was settling down and telescoping the steel cofferdam. This was accomplished by placing steel rails and timbers across the top of the cofferdam and under one of the sets of the timber shaft lining, allowing the latter to take a bearing on them. Pumping was then resumed, and pieces of sheet iron were forced down alongside the sheet piles in an effort to locate and stop the holes where the quicksand was entering the shaft. As a last resort grout was pumped down to the ledge through a 2-in. pipe, it being withdrawn and moved frequently. This was allowed time to harden and the excavation was resumed. After an advance of a few feet had been made, the sand and water broke in from the bottom and boiled up as usual. In August the mining company decided that the shaft could not be sunk by ordinary methods, and called on The Foundation Co., of New York City, who devised plans and contracted to put the shaft down to and far enough into the ledge to make a watertight joint with the rock.

Operations were resumed early in October, 1906. The new plan involved lining the upper or timber part of the old shaft with reinforced concrete, leaving a shaft 13 ft. 6 in. by 6 ft. 1 in. having two 4-ft. 6-in. by 6-ft. 1-in. hoisting compartments at each end, and one 6-ft. 1-in. by 3-ft. 6-in. compartment in the center for pipes and ladders. An air-tight concrete diaphragm fitted with an air shaft and lock was then to be built on the upper ends of the steel sheet piling so that the excavation and timbering below could be done under air pressure. Provision was to be made to suspend the entire weight of the timber lining from the diaphragm until a bearing was secured on the ledge. It was decided to pump out the shaft as low as it had been excavated, about 18 ft. below the tops of the steel sheet piles, and timber from that point up to where the concrete diaphragm was to be; then to construct the diaphragm and line the old timber shaft above with concrete up to the surface of the ground, at the same time replacing the timber bracing with two 6-in. concrete transverse partition walls, reinforced with horizontal ⅝-in. square rods in each side on 6-in. centers.

On account of the dangerous condition of the timber shaft and because it had been strengthened from time to time with cross braces, which left very little working room, this order of operations was found to be impracticable and it was decided that the old timber shaft must be made secure and safe first. Accordingly the weight of the shaft was transferred from the tops of the sheet piles to the surface of the ground by putting in some extra heavy 60-ft. bearing timbers across the top of the shaft at the surface and connecting the timber lining to them by twelve 1¼-in. bolts. The cross timbers and rails on which the lining formerly rested were then cut out, leaving the lining again suspended from the surface.

A 2-ft. space was then cleared of bracing and broken struts at the bottom of the timber shaft, and forms were started preparatory to placing the lining and division wall concrete. Great care had to be taken in cutting out and shifting the struts and braces to make room for the concrete, which was deposited in sections about 2 ft. thick. The timber in the shaft was cracking and moving a good deal of the time while this work was being done, and it was difficult to persuade men to stay in the shaft. A few of the crossbrace ends were embedded in concrete and after the concrete had set the braces were cut and the ends dug out, the resulting space being filled with concrete. Horizontal reinforcing rods ⅝-in. square were placed in the concrete lining on 12-in. centers. A 6x18-in. recess was left 1 ft. from the bottom of the side and end walls to engage the edges of the diaphragm. This work necessarily proceeded very slowly, temporary braces and jacks being used continually. The scarcity and poor quality of the labor available also tended to make the work go slowly. On Nov. 9, the concrete lining had reached a point 10 ft. from the top of the shaft and it was then considered to be in a perfectly safe condition.

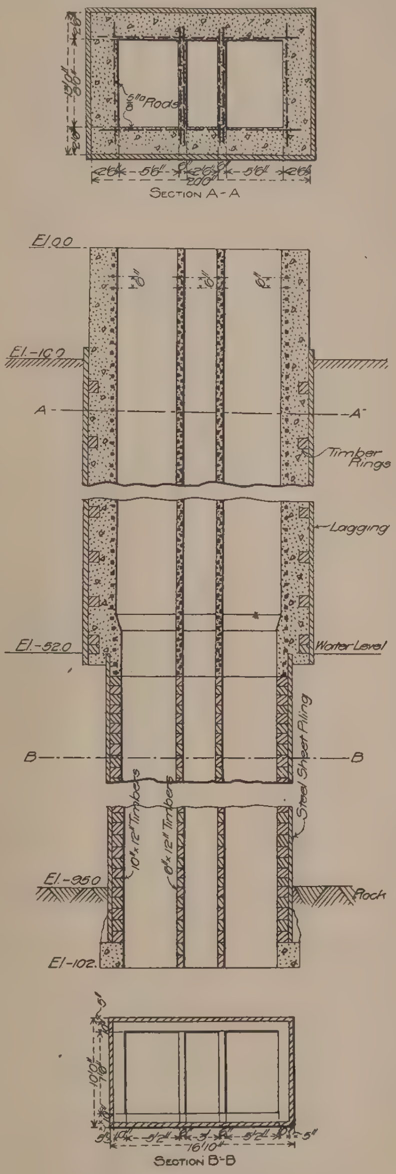
The shaft was then pumped out to the sand, about 18 ft. below the bottom of the proposed concrete diaphragm, and the work of lining the shaft from this point to the diaphragm with rings of 10x12-in. timbers was commenced. This was a difficult piece of work, for the bracing then in the shaft at this point had to be removed and solid timbering substituted. Each ring of timbers rested immediately on the one below it, the joints between the successive rings being well calked with oakum.

The rings were braced transversely by two solid walls of 6x12-in. timbers, each placed 1 ft. 9 in. from the center of the shaft, as shown in an accompanying illustration. These also served to divide the shaft into three compartments, a skidway at each end and a pipeway and ladderway in the center. In each of the four corners of the shaft a 3½x3½x½-in. angle was bolted to each set. These secured and braced the ends of the timbers in a very satisfactory manner.

The centering for the diaphragm was suspended by twelve 1¼-in. bolts from 12x12-in. timbers extending across the finished concrete walls of the shaft. The diaphragm was a 5-in. slab of concrete and was built into the keyway left when the concrete lining was built, as before mentioned. The slab was heavily reinforced both transversely and longitudinally with 1¼-in. steel bars placed on about 6-in. centers. Eight 1¼-in. steel bolts were built into the slab and after the concrete had set sufficiently, the weight of the timbering below the diaphragm, which was built on the sand bottom, was transferred to these bolts so the sand could be excavated below the timbers without danger of settlement. A section of 48-in. air shaft had also been built into the roof, and when the concrete had set this shaft was continued up in one of the hoisting compartments to a point 30 ft. above the diaphragm. A Moran air lock was then connected to the top of the air shaft and air was turned on Dec. 18, 1906.

The work of excavating the shaft and placing the timber lining inside the steel sheeting was carried on rapidly for 12 ft., though the old 3-ft. crib previously mentioned had to be cut out and sent to the surface. All the timber lining was lowered through the air lock and shaft from the surface, where it had previously been framed. As each stick was put in place it was suspended from the timber above it by 2¼x¾-in. iron straps 24 in. long fastened to each timber by two 7x¾-in. lag screws. After ten courses were suspended in this manner, an iron strap of the same dimensions, but long enough to engage ten sticks of timber instead of one, was fastened to the wall in the same manner and attached to the roof bolt, as an additional precaution.

Between the outside of the finished shaft and the steel sheet piling for the first 23 ft. there was a space of 3 to 6 in., which was filled with rich concrete. This had to be suspended from the diaphragm like the timbers, and had to be put in from the bottom instead of the top. However, the general line of the steel piling slanted toward the center of the shaft, and it was not long before the space enclosed by the piling was not any too large to receive the timber lining.



Sections of Mine Shaft.

Twelve feet down it was discovered that four of the sheet-piles had been deflected from their course by a boulder and, being driven further, had curled up inside the shaft in almost true circles, 4 to 6 ft. in diameter. These were cut off with pneumatic tools and sinking was resumed. On account of the large space left open for the escape of air, caused by cutting out these four piles, and the peculiar nature of the ground, great difficulty was experienced from this point down to the ledge. In a good many cases it was possible to put in place a set of timbers only by the aid of jacks and an air jet, owing to the difficulty in keeping down the water level.

As sinking progressed more steel sheet piles were encountered that had broken away from the general line of the piling and been forced into the shaft area. Some of them had to be cut several times as the excavating and timbering proceeded. In all 143 cuts were made in the steel sheet piles. This was slow work, as a good many of them had to be cut 14 in. below the surface of the sand and water to allow for placing the timbers. The work was further retarded by a fire caused by the flame of a miner's candle, and at another time by the breaking down of an air compressor, and it was not until March 12, 1907, that the ledge was reached.

It was the intention of the contractor to stop the shaft at the ore ledge and, after making a tight joint, turn it over to the mining company, but the ledge was found to be so badly broken up and seamy that it was finally decided to carry the excavation under air into the ledge. After going into the ledge 12 ft., it was thought best to stop further sinking under air pressure and finish the shaft in the open. Accordingly a tight joint was made with the ledge and air was taken off on May 10. The walls of the shaft were found to be tight and in good condition. Very little water came in, and that only in the center of the ledge.

The Syracuse Mining Co. was represented by Mr. C. H. Munger, general manager, and the work was done under the direction of Mr. F. W. Adgate, superintendent for The Foundation Company.

The Demolition of Masonry Arches.

The demolition of masonry arches over the double-track railway between St. Denis and Survilliers on the Northern Ry. of France, to permit four-tracking was recently done by an ingenuous method without interfering with traffic. The bridges were segmental arches with skewbacks below the track level thus giving a wide lateral clearance with a small vertical headway on each side of the tracks. In this space a timber falsework tower, triangular in transverse vertical elevation, was built on each side of the track with its upper surface closely fitted to the intrados of the arch. Slight cantilever projections adjacent to the tracks at the tops of these falseworks provided seats for a thin steel shield, put in position during the short intervals between trains and fitted closely to the masonry. This method was equivalent to reducing the span to a minimum and then closing it with a light steel arch which proved strong enough to sustain the masonry of the bridge above after the arch action ceased. The shield was only about 7 ft. wide and as the bridges were about 16 ft. wide it was necessary to move it twice for each bridge. The towers were accordingly seated on oak skids and first used to take down one end of the arch, then moved to the opposite and, after removing it, were replaced in the center and completed the demolition. The thickness of the steel shield was only about 2 in., leaving a clearance of scarcely more than 1 in. below it.

An Extra Adhesion Railway for mountain climbing has been built at Clermont-Ferrand, in France, which makes use of a double-headed rail mounted horizontally between the running rails, upon which horizontal flanged traction wheels underneath the cars bear for propulsion or braking. On the locomotives the horizontal wheels are geared to the main driving axles and adhesion is obtained by a pneumatically operated mechanism which forces them against the double-headed rail with a powerful toggle action. The locomotives weigh 33 tons and the pressure on the horizontal wheels may be caused to reach the equivalent of 50 tons, so that three coaches are hauled up grades ranging from 6 to 12 per cent. without difficulty. The line rises 3,566 ft. in its length of 46½ miles.

The Engineer as a Professional Man.

Extracts from the Annual Presidential Address before the American Society of Civil Engineers, Mexico Convention, July 8. By George H. Benzenberg.

The Constitution of our Society provides that the President shall deliver at the Annual Convention an address, presumably consisting of a general résumé of the most important work in progress and of whatever advance has been made in the engineering art during the past year. Such a statement, however, would be but a repetition of what is being currently presented by the various publications devoting their columns to engineering subjects. Through the perusal of these ably edited and carefully compiled periodicals, we are sufficiently enabled to keep fully abreast of the times, in a statistical and instructive way. It may not be inappropriate, however, to call your attention to the fact, that during no similar period in the history of engineering in this country have so many works of such gigantic magnitude, requiring the expenditure of such vast sums of money, been undertaken or entered upon as during the past year. Among these, the principal works, probably not over nine or ten in number, are all devoted to improving or enlarging present facilities for navigation, travel and commerce, or to providing new channels and new terminals for the accommodation of such, and involve the expenditure of nearly seven hundred millions of dollars, while nearly as large a sum is to be spent from public funds for the development or improvement of water supplies, the betterment of sanitary conditions, the reclamation of arid lands, and the construction or reconstruction of highways, bridges, and other public works for the health, relief, and convenience of man.

It is, however, not only the constantly increasing needs of commerce and transportation, and the comfort and welfare of the public at large, that engage the talent of the engineer. The prevailing tendency to acquire profit and benefit by the introduction of more economical processes of construction and manufacture, as well as by the reduction of wastes, makes it imperative to enlist his analytical and inventive skill and his trained and experienced judgment in almost every branch of human activity, and to secure his advice or approval in every important enterprise. Hence, everywhere, immense interests and ever-increasing responsibilities are being entrusted to the engineer by private as well as corporate organizations. So thoroughly has he been able to meet every expectation, to fulfill every obligation, and to demonstrate his ability to meet every emergency successfully, that his counsel is not only invariably sought in the line of design and construction, but very frequently also as to the possibility or probability of any undertaking becoming a profitable venture. It is in keeping with the world's practical grasping at every opportunity to profit by the knowledge of the highest and best exponents before entering upon or engaging in any great or important venture. These exponents, therefore, should not only be well informed, accomplished, and gifted in their calling, but they must also be the representative of the very best and highest type of that which is implied by American citizenship. Besides being designers and constructors of works for the upbuilding of commerce and every other industry, they should also, to come up to the standard of the profession, become foremost and eminent among their fellow men. The marked position of trust, influence, and eminence which the profession has attained so signally in the industrial world is undoubtedly due to the fact that engineering has become a science of the highest standard.

This progress has been particularly along the line which constitutes the very essence of engineering, and consists in establishing and advancing a thorough knowledge and understanding of the various properties of material, of the forces and latent energies of Nature, and of their economic and intelligent application to the needs and benefit of man. This present knowledge has been acquired by faithful and patient study, by close and careful investigation, by thorough and systematic experiments and tests, and by compiling and communicating the results by reports and publications, in order that the profession might have the full benefit of such research and continue the same for the information and benefit of its members.

Furthermore, the various engineering colleges and technical schools of to-day contain libraries whose shelves are stocked with treatises containing specific and valuable instruction in engineering, as well as with official reports on engineering work. They also possess complete laboratories, thus enabling the student in every branch of the profession to become at least somewhat familiar with the practical end of his study and to train his mind in the proper method of investigating and diagnosing the engineering problems which may present themselves. Moreover, every engineer of to-day, besides his collection of books of reference, keeps himself supplied with all the current literature and with every report and article published pertaining at least to that branch of engineering in which he is especially engaged, in order to remain well informed and abreast with the current conception, practice, and experience of the craft.

To promote and foster this service further, and to maintain the high standard of the profession among its members, as well as in the estimation of mankind, the profession in our country organized this Society, as well as many kindred associations relating to the different branches of professional work, for the advancement of the individual engineer.

To the younger generation of engineers a membership in this and kindred societies is of inestimable value, for it affords them the opportunity not only of participating in practical discussions, but also of having access to valuable documents, papers, drawings, and publications, containing a great mass of information which otherwise is not to be had, and which the earlier engineers did not possess. The present very rapid and remarkable growth in the membership of this Society demonstrates that this fact is now fully understood and appreciated.

It may be properly stated, therefore, that the present-day engineer largely owes whatever success he may have achieved, or reputable position he may occupy, primarily to the advantage which the profession has accorded him, through the close study and diligent research of others who have preceded him and have given the benefit of their learning and experience to the craft, and to which he in turn has likewise added his share for the benefit and welfare of others who may follow.

If this be true, and the engineer, because of this service and also the eminence of his profession, occupies to-day a higher position in the world and enjoys a standing and reputation which compares most favorably with that of any other profession, then the question very properly arises, what duty does he in return owe to the profession; what should be his attitude toward it and his brother engineer, and what position must he ever maintain before the community at large, in order to receive always the full confidence to which he and it should and must always be entitled? The query is a pertinent one, which no engineer should disregard or hesitate to answer.

With the prevailing and ever-increasing tendency of the present day to acquire wealth rapidly, many temptations are thrown in the way of the engineer. Individuals or corporations engaged in monopolizing natural or artificial advantages for selfish purposes, to the detriment of others, do not hesitate to seek the aid of the engineer in furthering their objects. They tempt him to close his eyes to questionable and reprehensible practices. The engineer who is the head of, or is employed in, a municipal or other government department, or who has charge of work executed under contract, is nearly always exposed to such temptation. Every kind of influence is brought to bear upon him to exercise the duties of his office for the benefit of some individual, party, or combination. It assumes every conceivable guise, and is frequently used in such an insidious manner that the unsuspicious mind is not aroused. How often has not the engineer on municipal work been importuned to place the inspection of such work in the hands of someone whose sole qualification consisted in nothing better than the possession of political influence, and who was expected to be not overscrupulous in carrying out the instructions of the engineer?

The element of loyalty to duty, of absolute faithfulness to every honorable engagement, which is not infrequently ignored in many professional and business enterprises, must ever be a distinguishing characteristic of every member of this profession. No matter what may be thought, said, or done in any other walk of life, that much, at least, the engineer owes to his calling, which through its combined achievements reflects credit and reputation upon the individual. The world must know that the engineer does not lend himself, his ingenuity, his skill, or his experience to aught but what is right, and that, having the privilege of declining, his acceptance of a commission means that he is not, knowingly, lending himself to any questionable undertaking, and that his sense of probity, his pride in his work, and his devotion to his profession rise above every other influence or consideration.

To his brother engineer he should always be fair minded and honorable. His sense of justice and equity will never allow him for one instant to forget that he himself is not infallible, that there is often more than one way of solving a problem, and that the work of the "other" may be capable of as good results, with as high economy, as his own solution; nor will he forget that his fellow engineer has the absolute and unqualified right to receive the same consideration he would himself expect. He will, with the innate spirit of a gentleman, honor and respect the opinion and judgment of his fellow engineer, if given in good faith, to the same extent that he values his own; for the argument and reasoning of the one may be as sincere and logical as that of the other, and may possibly be founded on as good or even better experience, the relative merits of which can only be determined by unbiased consideration. He should also recognize that the reputation of the individual is inseparably linked with that of the profession, that the honor and glory of one reflects upon the other, and that, therefore, by maintaining the standing and reputation of its members, he is but maintaining his own.

The respect and esteem which a community entertains toward any profession or its members is always in proportion to that which the members of such profession entertain toward one another.

Unfortunately, there are those who do not hesitate to presume upon the general confidence accorded by the community to any profession, and to exploit it or its reputation for purely personal profit and gain. In the other professions the law has been invoked to provide protection against the unauthorized acts and unprofessional practices of members or individuals whose dealings and transactions tend to reflect discredit upon their several occupations. Happily, there has been no necessity for the enactment of any special statute to protect a community against imposition from the engineer or from one who claims to be a member of our profession, probably because his deeds and works speak for him, while his misdeeds advertise themselves with surprising rapidity.

The engineer is not infallible; he may make mistakes, and it would be remarkable indeed if he did not at some time err in his judgment; but, so long as he is conscientious, exercises every care, and exhausts all his resources in the performance of his obligations, it cannot be said that he is culpable or negligent in his duty. It is necessary, therefore, that he should always be circumspect and vigilant. That the engineer has recognized these obligations toward his profession is evidenced by his standing in the community to-day, and by the trust and confidence with which every material development has been committed into his hands.

Strength of Red and Yellow Douglas Fir Bridge Stringers.

The terms red and yellow fir are not thoroughly defined. By some, only close-grained, bright yellow sticks are designated yellow fir and all other sticks called red fir; while others call only close-grained sticks of a pronounced red color red fir and all other material yellow fir. Both red and yellow fir are secured from the same species, Douglas fir, and often from the same tree.

Strength of Red and Yellow Douglas Fir Bridge Stringers.
(Yellow fir expressed in percentages of red fir.)

Kind of Fir.	Grade.	Number of Tests.	Rings per Inch.	Per Cent. Moisture.	Weight per cu. ft. As Tested.	Weight per cu. ft. Oven Dry.	Unit Fiber Stress at Elastic Limit.	Modulus of Rupture.	Modulus of Elasticity.
Red	Select	48	10.3	29.6	38.2 lb.	29.5 lb.	4,427 lb.	6,974 lb.	1,645,000
Yellow	Select	45*	17.5*	87.0	94.0	97.0	101	96	100,000
Red	Merch.	71	9.0	29.7	35.9	27.7	4,056	6,019	1,534,000
Yellow	Merch.	38*	16.4*	90.0	97.0	99.0	101	102	97,000
Red	Seconds	43	7.5	27.4	35.7	28.0	3,674	4,923	1,319,000
Yellow	Seconds	11*	14.5*	98.0	104.0	105.0	99	106	98,000

* Not expressed in per cent.

An analysis of the strength tests made by the Forest Service on Douglas fir bridge stringers is shown in the attached table. These stringers were graded according to the export grading rules of the Pacific Coast Lumber Manufacturers' Association, and in the table are grouped by grades. In classifying the stringers according to color all timbers of a reddish tinge were called red fir, and all of a yellowish tinge were called yellow fir. The rings per inch shown in the table indicate that yellow fir is of slower growth than red fir. It also ranges higher in grade. Of the 94 yellow fir stringers tested 47.8 per cent. were selects, 40.4 per cent. were merchantables, and 11.8 per cent. seconds. Of the 162 red fir stringers tested 29.8 per cent. were selects, 43.8 per cent. were merchantables, and 26.6 per cent. seconds, but, grade for grade, these tests show that there is practically no difference in the strength and stiffness of red and yellow fir in bridge sizes.

A CO_2 Recorder has been constructed for furnace gas investigations by the Cambridge Scientific Instrument Co., which depends on the variation in pressures of waste gases when confined in a vessel with porous walls. Under such conditions the outside air diffuses into the vessel more rapidly than the furnace gas diffuses outward, and the pressure rises within the vessel. The rise depends upon the difference in specific gravity of the gas and the air, which enables the proportion of CO_2 to be measured.

Proposed Code of Ethics for Electrical Engineers.

Submitted by a special committee of the American Institute of Electrical Engineers at the Niagara Convention.

General Principles.—1. In both his professional and his business relations the electrical engineer should follow strictly the same ethical principles that are recognized in the social relations of every-day life. He should consider himself personally responsible for the character of the enterprises and the persons with which he is associated professionally.

2. Before entering into professional relations, it is therefore the duty of the electrical engineer to satisfy himself that the enterprises with which he connects himself are of a legitimate character. If, after becoming associated he finds them to be of a questionable nature he should sever his connection as soon as possible. It should not be considered an excuse that his connection extends only to legitimate engineering work.

3. An electrical engineer permitting the use of his name in any enterprise or exploitation becomes morally responsible for the character of the latter. He should therefore not allow the use of his name in connection with anything upon which he is not qualified by training and experience to exercise competent judgment.

4. The electrical engineer should take care that credit for engineering work is attributed to those who, as far as his knowledge of the matter goes, are the real authors of such work.

5. The electrical engineer should incline toward and not away from standards of all kinds, since standardization is peculiarly essential to the general progress of the profession. This applies to construction, measurement and expression, or nomenclature, as well as to conduct, or ethics. Even the tendency to give individuality by providing special construction may sometimes be avoided with advantage.

Relations of the Electrical Engineer to His Employer, Customer, or Client.—7. The electrical engineer should consider the protection of his client's interests as his first obligation, and therefore should avoid every act that would be contrary to this duty; if any other consideration such as professional obligations or restrictions interfere with his so acting, in accordance with the expectation of his client, he should inform him of the situation.

8. He can honorably accept compensation, financially or otherwise, from one side or party only, interested in the same matter. The electrical engineer, whether consulting, designing, or operating, may therefore not accept commissions, either directly or indirectly, from other parties dealing with his principals.

9. Electrical engineers in a position to decide on the use of inventions, apparatus, etc., should not be financially interested in their use, as by receiving a royalty, etc., unless the matter is clearly understood by the client.

10. Electrical engineers should not accept employment while financially interested in a rival concern except upon the express permission of both parties. An electrical engineer may be employed by more than one party, as in the case of a consulting engineer, when the interests of the parties do not conflict and it is understood, as is usual in such cases, that he is not expected to devote his entire time to the work of one party but is free to enter into other engagements. A consulting engineer permanently retained by a party should notify other prospective employers of this affiliation before entering into relations with them. A consulting engineer when not exclusively retained by one side may advise rival concerns, with the full knowledge of all of them and upon taking care that the interests of the parties do not conflict in the particular matter handled.

11. Operating engineers should consider themselves responsible for defects in apparatus or dangerous conditions of operation, should bring the same to the attention of their employers and urge remedial action. If the causes of the danger are not removed they should withdraw.

12. An electrical engineer should in general be considered directly responsible to his employer or client for the successful fulfilment of the work upon which he has been engaged and for its satisfactory performance as a whole. It should therefore be clearly understood at the outset just what the extent or the limitations of responsibility of the engineer are to be. Whether he has been employed merely as designer or whether he is retained to design and to superintend construction; whether to design only the chief features, or to pass as well upon all details of the apparatus that is to be installed. Attention should be directed to the fact that defects in the manufacture of material or apparatus is a matter distinct from the matters of design or installation. An engineer should not be held responsible for the unsatisfactory performance of a plant resulting from defective aparatus furnished, unless he has undertaken to include this subject.

Relations of the Electrical Engineer to the Ownership of the Records of His Work.—15. The following general principles should be recognized:

If in executing his work, the electrical engineer uses data or information which are not common and public property, but which he receives, directly or indirectly from his employer, or if the problem solved by the engineer is met in the pursuit of his work for his employer, and is not of such character that his attention would have been directed to it regardless of his relations to his employer, the products of his work, in the form of inventions, plans, designs, etc., are not his private property, but the property of his employer, though the engineer may be entitled to special remuneration for such inventions, etc.

16. If in the execution of the work the engineer uses only his own knowledge or data or information which are public property by prior publication, etc., and receives no engineering data from his employer or customer, except performance specifications, the results of the work, such as inventions, plans, designs, etc., are the private property of the engineer, and his employer or cusomer is entitled to their use only in the specified case.

17. All the work done by the engineer in the form of inventions, plans, designs, etc., which are outside of the field of engineering for which his employer has retained him, are the engineer's private property.

18. When an engineer or manufacturer builds apparatus from engineering designs supplied to him by his customer, the designs remain the property of the customer and should not be duplicated for other customers without express permission. When the engineer or manufacturer and his customer are jointly to work out designs and plans or develop inventions, a clear understanding should be arrived at before the beginning of the work regarding the proportionate

rights of the ownership in any inventions, designs, etc., that may result, since in such case both parties should be considered to have rights therein.

19. Any engineering data or information which an electrical engineer obtains, directly or indirectly, from his employer or customer, or which he creates as a result of such information, must be considered by the engineer as confidential; and while the engineer is justified in using such data or experience in his own practice as going towards his education, the publication thereof without express permission is improper, as is also its use in producing for other parties, work that is characteristic of the original customer or employer.

20. Designs, data, records and notes made during his engagement by an engineer employed under permanent engagement, and referring to his work, are his employer's property. The same matter in the case of a consulting electrical engineer are the property of the consulting engineer.

21. A customer, in buying apparatus, does not acquire any right in its design beyond the use in the apparatus purchased. A customer of a consulting engineer does not acquire any right to the plans made by the consulting engineer except for the specific case for which the apparatus was built or the plans made.

Relations of the Electrical Engineer to the General Public.—22. The electrical engineer should endeavor to assist the public to a fair and correct general understanding of engineering matters, spread the general knowledge of electrical engineering, and discourage wrong or exaggerated statements on engineering subjects published in the press or otherwise, especially if these statements are made for the purpose of, or may lead to inducing the public to participate in unworthy schemes.

23. Controversies on engineering questions, however, should never be carried on in the public press, but should be confined to the technical press and the engineering societies.

24. First publication of inventions or other engineering advances should not be made through the public press but rather through the technical press and the engineering societies.

25. The publications which an electrical engineer is justified in making through the public press should therefore be of a historical, educational, instructive or similar character and should not relate to controversies between engineers or on engineering questions, to new inventions, etc., nor contain technical criticisms of fellow engineers, and it should be considered unprofessional to give opinions without being fully informed on all the facts relating to the question, and on the purpose for which the opinion is asked, with a full statement of the conditions under which the opinion applies.

26. In giving expert testimony before judicial bodies, the electrical engineer should confine himself to brief and clear statements on engineering or historical facts. He should not give personal opinions without so expressly stating, and should avoid pleading on one side or the other.

Relations of the Electrical Engineer to the Engineering Fraternity.—30. The electrical engineer should take interest in and show due regard for the electrical engineering societies and the technical press.

31. He should assist his fellow engineers by exchange of general information, experience, instruction, etc.

32. He should not take a position left by another electrical engineer without satisfying himself that the former has left it voluntarily, or for proper reasons.

33. Where engineering work is in charge of an electrical engineer, no other electrical engineer should undertake the work except on request of or in co-operation with the electrical engineer who had charge of the work before, unless the latter's connection with it has already terminated.

34. An electrical engineer in responsible charge of work should not permit other engineers or non-technical persons to over-rule his electrical engineering decisions. If this is done and persisted in, he should as soon as is practicable withdraw.

35. In engineering work in charge of a board of engineers, the respective limitations of the authority of each should be decided at the outset, and each electrical engineer should give full and complete information on his part to the other engineers and insist on this being reciprocated.

Relations of the Electrical Engineer to the Standards of His Profession.—40. The title "electrician" should be applied to those having practical training sufficient to enable them to carry on intelligently certain classes of electrical work, such as the installation of electric lights, signaling systems, and the operation of small electric plants.

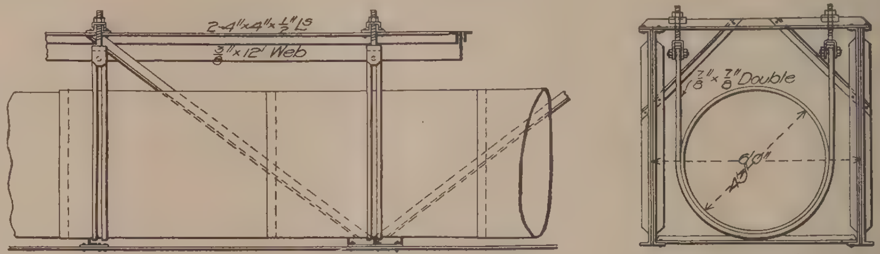
41. The title "electrical engineer" should be applied only to graduates from the electrical engineering school of universities of recognized standing, and such men as possess an equivalent knowledge of electrical engineering.

42. The title "consulting electrical engineer" should be applied only to those electrical engineers who possess such knowledge and experience in electrical engineering as would qualify them to full membership in the American Institute of Electrical Engineers.

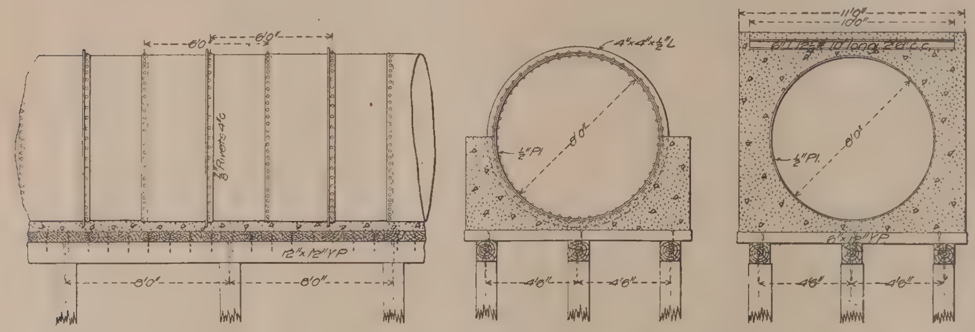
Large Riveted-Steel Sewers in Jersey City, N.J.

An 8-ft. riveted-steel storm-water sewer is now being built in 12th St., Jersey City, N. J., to serve a high 600-acre tract of thickly settled property known as the Hudson City section. The sewer has its origin in the Horseshoe Meadows below the Hudson City section and will extend eastward about 5,200 ft. to its outlet in the Hudson River. At the origin the invert is at El. 65 and at the outlet it is at El. 2, or 4.5 ft. below mean sea level. The average elevation of Hudson City is about 125. This district is at present drained by a 5½-ft. riveted-steel sewer, which is entirely inadequate to carry the storm flow.

Formerly during every severe rain storm cellars in Hudson City were flooded. This has been remedied by constructing a 5-ft. brick sewer through the section and connecting it with the steel pipe at El. 65. This has transferred the water from the residential section to the head of the steel pipe, where it is placed under pressure. The new sewer will also receive at its upper end the flow from cast-iron and steel pipe extensions of the old sewers, and is designed to operate under a maximum head of about 65 ft. It will receive no water from the meadows or neighboring low land.



Side and Sectional View of Pipe Bridge, Jersey City Sewers.



Concrete Reinforcement of Jersey City Riveted-Steel Sewers.

The pipe is made of ½-in. plates, 6 ft. 3 in. wide, and is delivered and laid in 18-ft. sections. All the seams are single-riveted, with 3-in. laps and ⅞-in. rivets 4 in. between centers. Around the pipe, midway between the successive circumferential seams, 4x4x½-in. stiffener angles are attached with ⅞-in. rivets on 6-in. centers. Each 18-ft. section is coated with refined asphaltum in the usual manner. The field riveting is done by hand.

Near the upper end of the new sewer it crosses the lands of the Erie R. R., passing under several tracks. Here and in the soft meadow land special support is secured by three lines of piles, spaced 5 ft. center to center longitudinally and 4 ft. 6 in. transversely. These carry three lines of 12x12-in. yellow pine stringers, spiked to the pile tops, and on these is laid a floor of 6x12-in. pine plank. Under the railroad tracks the angle stiffeners are omitted and the pipe is encased in concrete, as shown in an accompanying illustration, 6-in. 10¼-lb. I-beams spaced 2 ft. on centers being imbedded in the concrete over the pipe as additional reinforcement. In the railroad property where there are no tracks at present and in the soft land the angle stiffeners are used and the concrete casing is carried up to the elevation of the center line of the pipe, where a square shoulder is left on each side, on which the concrete and I-beam arch can be built up if needed later when more tracks are laid. The concrete is a 1:3:6 hand-made mixture of Vulcanite Portland cement, sand and crushed stone.

The pipe laying was begun at the upper end of the sewer and has proceeded about 1,100 ft. All the unloading and other handling of the pipe and all excavation and backfilling has been done with a Brown locomotive crane, equipped with a Haywood 1-yd. orange-peel bucket or with hooks and chains, as the work required. This crane is operated on a standard-guage track laid along the street in the center of a 21½-ft. strip between the south curb and the south edge of the 8½-ft. trench, which is dug close to the north curb. The track extends to the switch tracks of the Erie R. R. The pipes, which weigh about 6 tons each, are delivered on flat cars, two 18-ft. sections being placed on each car. They are unloaded by the crane and piled two tiers high along both sides of the crane track with their axes perpendicular to the track. At times as many as 75 pipes have been at hand. When one is needed the crane runs back, picks up the pipe, carries it to its place and lowers it into the trench. The time required to do this, when the distance traveled does not exceed about 500 ft. each way, has sometimes been as low as twenty minutes.

In excavating the trench the top 4 ft. of soil is delivered into 2-yd. dump wagons and hauled away. The remainder of the material is delivered at once over the first length of pipe behind the crane so that there is seldom more than 50 ft. of trench exposed at one time. About 5 ft. below the unpaved street surface, where the trenching is now in progress, is hard pan in which there are many small boulders and some large ones. This has to be loosened with hand picks before the shovel can handle it and even then the bucket is never well filled and sometimes picks up only a very little. Nevertheless this method is cheaper than digging the trench by hand.

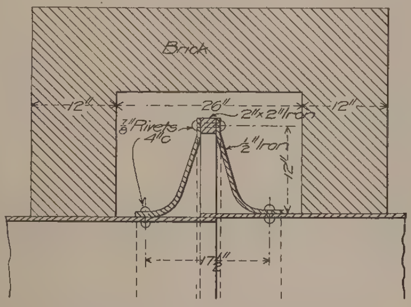
Two-inch yellow pine sheet piles are used. These have been driven with a 2¼-in. cylinder, 100-lb. McKiernan steam pile driver. This has proved too light to force the piles through the hard pan rapidly and a 3½-in. cylinder 600-lb. hammer of the same kind is to be substituted. To facilitate handling the hammer it is swung with a chain block and tackle from a four-legged tower about 18 ft. high, mounted on a small car which runs on a 30-in. track along the outside of the line of piling. The tower is formed by two braced A-frames, one on each side of the car, the one nearer the piles being vertical and the other inclined so that the four legs meet at the top. A platform is provided near the top of the tower on which the man hauling the hoisting tackle stands. The hammer operator stands on a lower platform. Steam is supplied to the hammer by a 40-h.-p. horizontal boiler, a line of 1-in. pipe with hose connections being laid between the rails of the crane track from the boiler to the hammer. This boiler is moved when necessary with the locomotive crane. In one instance it was swung across the track and carried about 300 ft. while under a steam pressure of about 40 lb.

While the pipe was being laid in the meadows a considerable quantity of water was encountered which was handled with an 8-in. Craft centrifugal pump. Later the quantity of water materially decreased and it is now collected in the pipe behind dams of bags of sand, three tiers thick, and pumped out with a 3-in. Maslin pulsometer, supplied with steam from the boiler that supplies the pile driver. When the water gains on the 3-in. pulsometer another is added. This second pulsometer is supplied with steam by a vertical 20-h.-p. Erie boiler mounted on a standard-gauge truck which can be run over the crane track to any point along the sewer. The truck is equipped with an A-frame and boom and tackle with which the pulsometer is lowered into the sewer through a manhole.

Manholes are placed at 500-ft. intervals and at similar intervals automatic duplex air taps and valves, made by the Eddy Valve Co. are installed. Expansion joints of the form shown in an accompanying illustration, are placed at 1,000-ft. intervals.

The sewage of the houses along Twelfth St. has been discharged in the past into a 3-ft. brick sewer built about 40 years ago, a part of which is being destroyed as the construction of the new sewer progresses. Eighteen-inch vitrified pipe lines will be substituted, placed close to the steel pipe one on each side.

A system of riveted-steel sewers of various sizes up to 8 ft., designed to relieve the present inadequate storm water sewerage system serving the Bergen district of Jersey City, has also been partly built. The conditions there are in many ways similar to those in the Hudson City district and the pipes and foundations in general are like those in Twelfth St. The 8-ft. sewer will operate under a head of about 35 ft. and its outlet will be in New York Bay. The construction of this system involved carrying the flow from a system of brick sewers over the Newark & New York R. R. on Jackson Ave. in a steel pipe line having an inside diameter of 4 ft. 5 in. The highway bridge over the railroad on Jackson Ave. is of the deck truss type and was originally designed for very light traffic. It has been reinforced from time to time with plate girders and trusses and now carries two street car tracks. The trusses and girders under the floor left no room for the pipe line, and because of this and the fact that the bridge is likely to be replaced before long, the pipe has been carried across by a through-truss bridge, the end bearings of which rest on the abutments of the highway bridge under the cantilevered sidewalk.



Expansion Joint, Steel Sewer.

The trusses are of the riveted Pratt type, 6 ft. 4 in. deep. placed 6 ft. on centers and having a span of about 64 ft. divided into eight panels. Roller bearings are provided at one end. To facilitate easy adjustment of the structure and pipe to variations in length due to temperature, the pipe is hung at each panel point from the lateral struts with adjustable slings made of two lines of ⅞-in. square steel rods, as shown in the illustration.

The designs for sewers and bridges were prepared by Mr. Charles A. Van Keuren, chief engineer of the Board of Street and Water Commissioners, of Jersey City, under whose general supervision the construction work has been carried on. Work on the relief sewer for the Bergen section was suspended last summer owing to a disagreement with the New Jersey Central R. R., under whose tracks the sewer must pass, and the contractor, the B. M. & J. F. Shanley Co., was relieved of the contract and paid for the material on hand. Mr. P. Connelly is the general contractor for the Twelfth St. sewer, Mr. W. A. Connelly, superintendent, and Mr. O. C. Stringham, engineer in charge. The steel pipe is supplied by the Thos. C. Basshor Co., Baltimore, Md.

THE WATER UNACCOUNTED FOR at Yonkers, N. Y., where practically all service pipes are metered, was 51.37 per cent. of the quantity supplied in 1906, as indicated by plunger displacement estimates. This is about the usual discrepancy between plunger and meter readings.

Some Effects of the Recent Earthquake in Jamaica upon Railway Structures.

By J. Monk Fletcher, Assoc. M. Am. Soc. C. E.

The earthquake which occurred in Jamaica on Jan. 14 of this year and destroyed its chief city, Kingston, caused comparatively little damage outside that city. The damage was confined to a strip about 30 miles wide, running across the island from southwest to northeast. It seems probable that the centre of the disturbance was somewhere at sea opposite and not very far from Kingston, but it is certain that this principal shock and the many smaller ones which followed were felt to a greater extent in Kingston than at any other place on the island.

The almost complete destruction of the city was, however, largely the result of the unsuitability of the buildings for withstanding earthquake shocks of magnitude. The general offices, locomotive shed and stores of the railway were of brickwork in lime mortar, built upon a foundation of earth, and were wrecked or very badly injured as regards the upper stories, and severely shaken and cracked in the lower stories.

A clock tower of brickwork about 80 ft. high collapsed and fell upon one of the locomotive shops, damaging it considerably. The freight store, which is a wooden building supported upon brick pillars, was almost uninjured, though nearly shaken from the supporting pillars, which were badly cracked and in some cases twisted bodily upon the vertical axis, being broken at about ground level or just above.

Outside Kingston upon the railway the damage done was not great, and was confined almost entirely to brickwork structures. One station building of brickwork was wrecked and several others more or less severely damaged. Lime mortar had been used in the construction of the buildings damaged.

The more important structures, such as bridges, viaducts and tunnels, remained intact. The abutment and piers of bridges are nearly all of concrete without reinforcement and with the exception of a little spalling under the seat of girders, show no signs of the very severe strains to which they were subjected. Viaducts of concrete, without reinforcement, are uninjured as are 20 to 30-ft. span concrete arch bridges under and over the track.

The tunnels are, where necessary, lined with concrete and in some cases show slight cracks, commencing near the junction of the invert with the side wall and extending vertically about 6 ft. The cracks are superficial and do not weaken the structure appreciably. One tunnel has a brick in cement mortar arch 13½ in. thick and this shows absolutely no signs of injury, although the side walls, which are of concrete, have slight cracks as mentioned above.

Concrete retaining walls without reinforcement withstood the shock well and were not damaged. A concrete sea protective wall, which had been completed only 2 weeks, suffered no damage. The wall is carried below sea level 5 ft. and rests partly upon hard blue clay and partly upon igneous rock and extends 16 ft. above sea level. It is built of 1:3:6 Portland cement concrete below and 1:4:8 Portland cement concrete above sea level, clean sea sand being used for the mortar. Hard limestone broken to 2½-in. gauge by hand labor was used for the aggregate. The wall is 8 ft. thick at the base and up to sea level, after which it is battened and stepped to a thickness of 1½ ft. at the top. No reinforcement is used.

Retaining walls of dry rubble masonry were, in some cases, damaged seriously, but where particularly well constructed no injury was done. Rubble masonry walls in 1:4 or 1:5 cement and sand mortar were uninjured.

The effects of the earthquake upon the track were very marked where the embankment crossed swampy land or land which was at or near sea level, the setlement in some cases being as much as 12 in. in 3 ft. At these places the track was also thrown very badly out of alignment. Many small landslips occurred, blocking the track temporarily.

Considering the magnitude of the earthquake shock and the large amount of damage done in Kingston, it is remarkable that so little damage was done to the railway. Traffic was maintained without any break and many extra trains were run for the purpose of carrying the homeless people from the stricken city to their friends in the country parts, thus helping the authorities to bring order out of chaos.

Erection of a Short Bridge by Long Span Methods.

The Smallheath Bridge, at Birmingham, England, carries a very heavy highway traffic and includes one 120-ft. and one 145-ft. riveted pony truss span about 17 ft. in the clean above the surface of the ground. The space under the 145-ft. span is entirely, and that under the 120-ft. span is mostly, occupied by a large number of tracks of the Great Western Ry., which have a very heavy traffic during week days and part of Sunday. To avoid obstructing the tracks, the trusses, 42 ft. apart, are supported on very heavy vertical steel columns instead of masonry piers, and to avoid interfering with the traffic a special method of erecting was developed which, although sometimes used for very long, high, or difficult erection, is rather costly and elaborate.

The vertical pier columns were erected and long transverse girders were seated on them, overhanging them several feet at each end. A transverse timber trestle bent was built between the tracks in the middle of the long span and on it and on the transverse girders were supported four lines of longitudinal girders, one line at each side of each main truss. These were very heavy lattice girders of special construction, tapered from 5 ft. deep in the middle to 2½ ft. at the ends, where they had solid ½-in. web plates. The flanges were 20 in. wide and the web diagonals were 6-in. flats. A solid floor of 14x14-in. transverse timbers and longitudinal planks was laid on these girders and on it the span was erected and riveted. After its completion timber cribbing was built to the ends of the girders and received their weight when the cambre blocking was removed. The erection platform being thus released was removed and the 360-ft. span was gradually lowered about 7 ft. to its bearing by hydraulic jacks.

The bridge is of the ordinary English type with massive riveted construction and buckle plate floors. The details are not of special interest except for the fact that the main truss diagonals have approximately I-shape unbalanced cross-sections with a web plate and single flange angles, the latter reinforced with a wide and a narrow cover plate. The ends of the girders have pin bearings in cast steel shoes and pedestals which at the expansion ends are seated on sets of segmental rollers submerged in tanks filled with special non-evaporating oil to above the tops of the rollers, thus protecting the under surface of the pedestal base. The 32x40-in. vertical pier columns are made with closed cross sections having four longitudinal and four transverse webs with 24 flange angles and have extended cap and base plates stiffened with gussets. The bases are secured by anchor bolts 10½ ft. long to reaction beams embedded in the masonry foundation. The design and erection of this bridge was fully described in recent issues of "Engineering," of London.

The Construction of the Seligman Building, New York.

The 11-story Seligman building, New York, occupies the whole of an irregular lot, having an area of about 5,400 sq. ft., and a front of about 100 ft. on William St., 90 ft. on South William St. and 50 ft. on Stone St. The building is of fireprof steel frame construction with brick walls and stone facing in fronts. The lower floor is chiefly occupied by a very large and handsome bank room, two stories in height finished with Italian marble. The upper floors are devoted to offices and each have about 5,000 sq. ft. of rentable area. The exterior walls 28 in. thick at the base are self-supporting up to the 9th floor, where they are 16 in. thick, and above that are carried entirely by steel girders from the wall columns.

The removal of the old building that formerly occupied the site was commenced about the 1st of May, 1906, the debris was removed and the site was excavated to ground water level at a depth of about 8 ft. below the curb. From the bottom of the pit concrete foundation piers were carried down to solid rock from about 43 to 47 ft. below the curb by the pneumatic caisson process. The foundations for the wall columns were made continuous, forming a solid concrete wall 6 ft. thick and from 30 to 40 ft. high, which encloses the four sides of the lot and is designed, as in several other buildings described from time to time in these columns, to form a sort of dam resisting the heavy outward pressure and excluding ground water from the deep cellar excavated within it.

Caissons for Wall Columns.

This dam was constructed in consecutive separate sections up to about 26 ft. long by the pneumatic caisson process. Each caisson consisted simply of a working chamber about 6 ft. wide and 6 ft. high inside, and from 20 to 26 ft. in length. The walls were made with solid horizontal courses of planed timbers sheeted and calked and the long sides were braced by transverse horizontal struts. They were built at the contractor's yard, delivered complete on trucks and set in position where required in the bottom of the pit by four large mast and boom derricks seated so as to command the entire area of the lot and the adjacent street and handle the caissons directly from the trucks to the required positions.

The tops of the caissons were covered temporarily with light roof boards above which molds were built, and in them were cast slabs of rich concrete. Collapsible steel air shafts were set in these slabs and the molds were extended above them by successive sections of detachable paneled courses with exterior horizontal frames of angle iron which were filled with concrete until the pier had been constructed to full height, clear above the bottom of the pit.

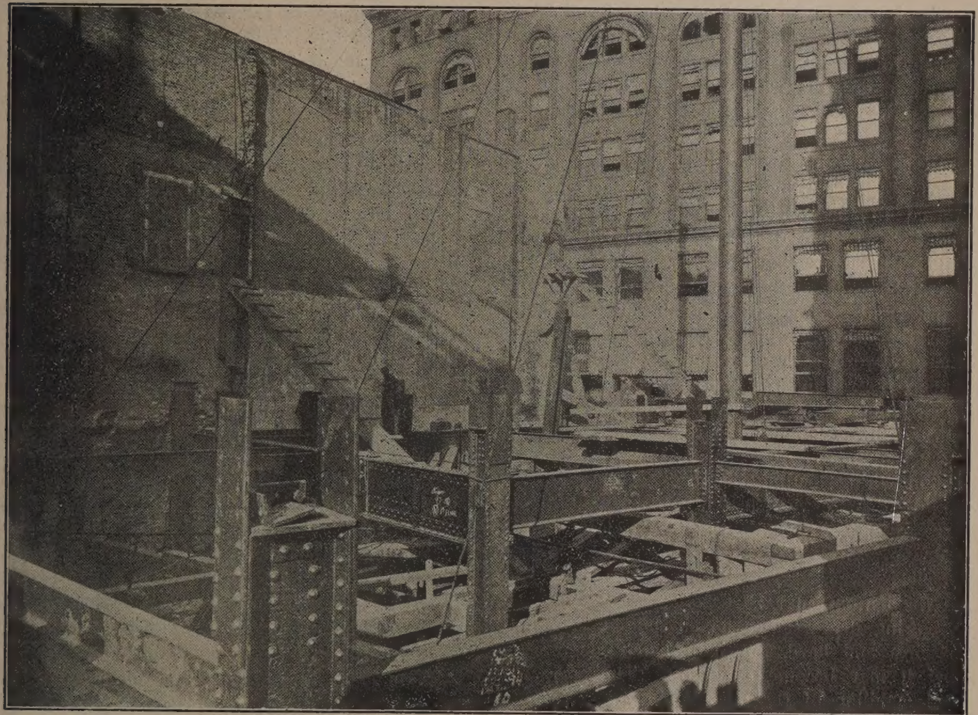
The caissons were put under air pressure, workmen entered them and excavated, and the great weight of concrete in position aided their rapid sinking to hard pan through very wet quicksand, gravel and numerous boulders, many of them of such large dimensions that they had to be blasted to clear the cutting edge of the caisson. One such was 10 ft. long, 6 ft. wide and 6 ft. deep and extended entirely across the caisson transversely. The cutting edge of the caisson was usually stopped near the upper surface of the hardpan and the excavation was continued below it from 4 to 8 ft. to the regular surface of the solid rock which was cleared off and received the concrete with which the caissons and air shaft spaces were filled after the steel air shafts were removed.

The caissons were sunk with clear spaces of about 12 in. between adjacent ends, and in order to bond them together and close the intervening spaces, semi-octagonal wells about 3½ ft. in diameter were cored out of the concrete in the center of the end face of each caisson. The outer faces of these wells were closed with horizontal plans and after both adjacent caissons had been sunk, the planks were removed and the space between them was excavated, the well thus formed being enclosed on both sides by horizontal boards connecting the adjacent caissons as the excavation proceeded.

The well was carried down with the original diameter to a depth of about 4 ft. and a short section of steel air shaft was embedded in it and filled with concrete. An air lock was connected to it, pressure was put on and a man entered and continued the excavation of the well with a reduced diameter down to the top of the working chamber below which point there was not room to admit him between the caissons and the excavation was made as best might be with a post hole digger. When the excavation was complete it was filled with concrete placed under pressure and forming a heavy key binding both caissons together and tightly closing that joint of the dam. The construction of the caissons and the method of sinking and connecting them was substantially the same as that illustrated in the description of the foundation for the Trust Company of America Building, located near the

Seligman Building and executed by the same contractors, which was published in The Engineering Record of October 27, 1906.

The 12 caissons were sunk and air pressure was removed from the last one in exactly 30 days. A sump was dug and steam pumps installed to drain the area enclosed by the wall caissons, and it was excavated by hand to a depth of 26 ft. below the curb, the spoil being loaded in steel buckets and delivered by the derricks to wagons in the street. As the dam proved efficient to exclude most of the ground water, no difficulty was encountered in carrying the concrete foundations for the interior columns down to solid rock by means of seven open rectangular wooden cofferdams. These were made complete at the contractor's yards where they were built in 8-ft. courses, each side consisting of a single panel of vertical 3-in. planks bolted to horizontal transverse timbers. These panels were assembled at the site with the ends of the inside horizontal pieces overlapping and bolted together to form transverse frames connecting the structure and receiving the cross braces. They were sunk by open excavation and loading, and like the pneumatic caissons, were filled with 1:3:5 Alpha Portland cement concrete mixed in a Ransome machine.



Erection of Steel Framework.

Besides the foundations for the interior columns a 16x16-ft. concrete pier was sunk in the same manner to solid rock to support the large steel vault. The sub-structure work involved the excavation of about 8,000 yd. of material and the construction of 2,000 yd. of concrete. The mechanical installation included two 100-h.-p. steam boilers, one 80-h.-p. Ingersoll-Rand and one 80-h.-p. McKiernan air compressor and the usual equipment of hoisting engines, pumps, counter-weight iron and ordinary tools. The work was done with an average force of about 100 men working day and night.

A 12-ton derrick with a 70-ft. mast and 65-ft. boom was installed near the center of the lot, guyed with six lines and operated by a Mundy hoisting engine permanently located in Stone St. With this all the steel work was unloaded from wagons, swung to place, and erected, usually at a single operation. The column loads on the wall piers were distributed over them by grillage I-beams carefully leveled with shims and bedded in grout. The upper flanges of these I-beams, having been adjusted as nearly as possible in the same horizontal planes for each group, were carefully dressed and filed until a uniform bearing was secured and a hot pressed steel plate 1 in. thick was bolted on top which received the cast-iron pedestal for these wall columns. The pedestals of interior columns were grouted on the carefully cut surfaces of granite capstones about 2 ft. thick. Great care was taken to make the pedestals exactly level and to locate them precisely, and all adjustments were carefully checked with transit and level.

All columns are made with rectangular closed cross sections of standard type and were built in two-story lengths having a maximum weight of 5 or 6 tons. There are in the first story and basement 25 columns, some of which support three twin girders over the banking room which carry four additional intermediate lines of columns in the ten upper stories and provide for a large unobstructed floor space in the first story. These girders are much the heaviest pieces of steel in the building and one of them about 35 ft. long weighs about 15 tons and was handled by the derrick boom unshipped and used in a vertical position as a gin pole, secured by six guy lines each adjustable by a hand tackle. The girder was lifted with a 10-part tackle made with ¾-in. steel rope rove through a number of separate sheaves and single and double blocks combined together to provide for the required number of parts. The structural steel in the building weighs about 1,000 tons, and its erection was commenced on Sept. 15 and finished Dec. 15, with an average force of about 25 men.

The weight and the reach of the derrick was so great that the erection stresses transmitted from it to the steel framework were larger than usual and special provision was made to stiffen the structure to receive them before the completion of the masonry walls and floors gave it final stability. The panels between the floor beams and columns in each longitudinal row were X-braced with ¾-in. wire ropes extending across three stories and provided with sleeve nut adjustments. Each double panel thus braced was also stiffened by a single 6x6-in. diagonal timber wedged at the foot against the wall columns and serving as a kicking piece. The columns in the transverse rows were similarly X-braced with wire ropes made from 1⅛-in. guys crossing two panels horizontally and three panels vertically. This system left one panel vacant at one side of the building and was completed without the use of the kicking pieces used in the other systems. When the erection was commenced the systems of bracing were carried up continuously several stories above the ground and afterwards the diagonals were removed from the lower stories and added to the upper ones as the erection progressed. This method was followed not only to clear the masonry but because after the walls and floors were built they lent additional stability to the framework and rendered the bracing unnecessary.

An Ingersoll-Rand air compressor driven by a General Electric dynamo was installed on the first floor and provided air pressure for the field riveting. A 3-in. vertical main was carried from its receiver to the roof and was provided at every third story only with an outlet from which connections were made to flexible tubes by which Chicago and Boyer hammers were operated by three rivet gangs. It was at first intended to utilize one of the steam pipe risers for this pneumatic service, but finally a special pipe was put in rather than wait for the steam pipe to be installed.

The floors and roof are of Roebling cinder concrete construction 4 in. thick and comprise about 65,000 sq. ft. of surface. Their construction was urged forward as rapidly as possible and they were usually kept within two stories of the setting of the beam tiers. The exterior walls contain about 1,200,000 red brick and were built from movable scaffolds suspended by long steel cables from drums carried at the upper story of the building. They were moved almost continuously and permitted the brick-layers to work to the best advantage without interruption.

The wall on all street fronts is faced up to the first floor with polished Crotch Island granite and above that with Bloomington limestone, about 35,000 cu. ft. of which was used. This was unloaded from the street by three boom derricks operated by steam hoisting engines and was stored in large quantities on the working platform 15 ft. wide which extended around three sides of the building over the sidewalk. The stone was set with hand power breast derricks located in every panel between columns, and every block was anchored to the brick work or to the steel framework with from one to three steel anchors, most of them galvanized and with extra large cross section. The work was done by an average force of about 20 men who completed it in about three months.

Mr. Francis H. Kimball and Mr. Julian Clarence Levi were the associated architects, Messrs. Weiskopf & Stern were the consulting engineers for the structural work. Mr. J. S. Griggs and Mr. J. B. Holbrook were the engineers for the mechanical and electrical installation. The Geo. A. Fuller Co. was the general contractor and erected the steel work and the brick masonry. The Foundation Co. was the sub-contractor for the substructure, Mr. W. H. McWhirter, Astoria, L. I., was the contractor for the limestone, which was set by McWilliam Bros. The National Fire-Proofing Co. furnished the hollow terra-cotta partitions, McNulty Bros. were the contractors for the plastering, Herts Bros. for the mahogany trim, the Wells & Newton Co. for the plumbing, and the Marine Engine & Machinery Co. for the plunger elevators, the L. H. Prentice Co. for the steam heating, ventilating and the mechanical equipment; the General Electric Co. for two turbines for the electric lighting plant, the L. K. Comstock Co. for the electric wiring, the Traitel Marble Co. for all marble, and the Waterproofing Co. for the hydrolithic finish of the cellar and pavements.

The Supervision of Construction of the New York State Highways.

The methods of making surveys and plans for highway improvements which are described in the manual issued some months ago by the State Engineering Department of New York have been outlined in recent issues of this journal. These articles have not taken up the supervision of construction, which is covered by other regulations prescribing the following procedures:

Engineers assigned to construction duty are held responsible for the construction of the road in accordance with the plans and specifications, from which no deviation is permitted without the consent of the division engineer. Engineers and their assistants do not leave the road during working hours without the consent of the Division Engineer, unless it be upon some business connected with the work.

Immediately upon assuming charge of a contract the engineer carefully checks the levels and measurements for the entire length of the road and marks on the adjacent fences, telegraph poles or other permanent objects in white lead paint each full station number, where this may be done without damage to private property. If the even station does not come opposite the permanent object the plus station is marked. If discrepancies are found to exist in levels or distance notice of them is sent at once to the division engineer.

The grade and alignment are given according to the following rule: "Set stakes on each side of the highway at every station, or more often if necessary, and near the fences or other permanent objects, where they are not liable to be disturbed. Prepare two small note books in ink, giving the horizontal distance from each stake to the center line of the macadam, and the vertical distance from the top of each stake to the crown of the finished macadam. After these note books are checked one shall be retained by the engineer in charge and the other shall be given to the foreman in charge of the grading, so that he may set his own intermediate grade stakes. At times when the engineers are not needed elsewhere these intermediate stakes shall be set by them."

If, to secure better results, any work in addition to that provided by the plans is thought necessary or advisable by the engineer in charge, a careful plan and estimate of the cost of such extra work is prepared and the whole matter submitted as soon as possible to the Division Engineer.

Engineers are expected to observe carefully the drainage of the entire road, especially during or after heavy rainstorms, and any changes in location or size of culverts or ditches that are considered advantageous are brought at once to the attention of the Division Engineer. Attempts are made during wet seasons to discover all soft and poorly drained portions of the road and if, in the opinion of the engineer, these places are not properly provided for in the plan, the Division Engineer is promptly notified.

No engineer is allowed to give any advice to contractors as to whether or not they can safely take their road rollers or other equipment over bridges. The contractors must assume all risks for such crossings.

Forming Subgrade.—In forming the subgrade for the macadam, stakes are set every 50 ft., or more often if necessary, along the line of the edge of the macadam and the finished grade marked on them. The proper form is given to the subgrade by a string stretched longitudinally between stakes, and by a template conforming to the desired cross-section of the subgrade. The elevation of the subgrade is checked before any stone is laid.

Before any subgrade is prepared for the macadam, all embankment and excavation is made for the full width of roadway. On embankment the portion outside the macadam is thoroughly rolled and consolidated before the trench for the macadam is formed. In excavation, all drainage ditches are excavated before placing the macadam, in order to drain the work thoroughly during the construction.

Care is taken to give the subgrade a sufficient amount of crown, so that after the road is rolled and completed it will have the full crown shown on the plans. This result is best obtained, according to the Department's experience, by raising the center of the subgrade 2 in. or more to allow for settling while the stone is being rolled, leaving the sides as indicated on the plans. If the contractor objects to this method, he is informed that, if the finished road has not the desired crown, it will have to be supplied with additional macadam. This precaution is specially needed on a yielding or plastic soil, likely to flatten under the action of the roller or the traffic.

The result to be obtained, when forming the subgrade, is a firm and solid foundation upon which to place the macadam, one that will not weave under the action of the roller, and on which the stone may be bound and locked together.

When unstable material is of too great an extent to be entirely removed, the facts are reported to the Division Engineer, with a detailed description of the extent of the trouble, and with suggestions as to its proper treatment.

On the clay soil frequently encountered in New York State it is considered absolutely essential that the subgrade be so formed as to prevent the clay working into the interstices of the stone during the rolling of the macadam. The Department states that this can best and most economically be accomplished by placing a layer of gravel upon the clay subsoil, if a bank can be found within hauling distance. A layer of ¾-in. stone or screenings will often give satisfactory results, where no other material is available, and in the more unstable places a layer of field stone, varying in size, with the larger at the bottom, may be used.

During dry weather a subgrade of clay may be firm and hard, but immediately upon being wet it may become very soft. The sprinkling and puddling of the macadam often causes the latter condition, and hence the necessity of providing against the clay working into the macadam.

On sandy soil, rolling has little effect and is continued only long enough to settle the subgrade in place. If the sand is very fine, or is quicksand, a layer of gravel is considered the best treatment possible and will usually give as firm a subgrade as is desired.

Culverts.—Masonry design may be substituted for concrete design at the option of the contractor, the height of parapet above the top of cover being the same in all cases, 9 in.

In setting culverts of minimum length, where the channel is practically level, a fall of about 3 in. is allowed in the culvert and the shape of the shoulders of the road is varied slightly to bring the slope lines to the proper places. Where a culvert is under more than the minimum amount of embankment, either at one end or at both ends, the culvert is lengthened beyond the minimum length instead of raising the parapet and wings to hold the slope. It is not necessary in any case for the elevations of the tops of parapets to be the same, for if so placed, the one on the down-stream side usually appears higher than the other.

Quarries.—If a quarry, after being developed, contains layers of slate, shale, thin layers of soft stone or undesirable stone of any kind, the contractor is required to select from the general run only such stone as will comply with the requirements of the specifications and contract.

If, in the opinion of the engineer, the quarry should be discontinued as a source of supply, the contractor is directed to suspend immediately and a report is sent at once to the Division Engineer.

Field Stone.—Where "local stone" is permitted by the contract and the contractor proposes to use field stone rather than stone from quarries, the following directions are made binding:

"The stone must be selected from the general run of stone found in the fields and stone walls or fences; those used shall be hard, durable and of compact texture, and all disintegrated stone, as well as soft sandstone, shale and slate, must be rejected. Where the field stones are of the flat variety, the minimum thickness allowable for use is 2 in., and where the stones are round cobbles, the minimum diameter allowable is 5 in. unless otherwise ordered by Division Engineer. It will, therefore, be seen that old walls or fences can not be cleaned up entirely in crushing for macadam. When the quantity of harder stone is insufficient for the whole road the softer stone may, if of approved quality, be crushed and used for the lower course. This must not be allowed without the approval of the Division Engineer in each case."

Crushing.—The engineer in charge is required to note frequently the working of the crusher, in connection with the inspection of the crushed stone. If the product seems to run smaller than the screen should give, it may be due to the section of the screen being too short, or the screen may turn too fast, or it may have too great an inclination. The bins are often allowed to get too full and stone from one bin will run over into another. The specifications requirements regarding crushed stone are rigidly enforced.

Courses.—The thickness of the courses of stone are regulated by the use of several hardwood blocks, laid on the subgrade or on the next lower course, as the stone is being spread. These blocks will be one and one-third the required thickness of the course to be formed and the loose stone must be spread to the full height of the blocks.

Spreading Screenings.—The contractor is not allowed to haul heavy loads of screenings over the stone which has been placed, until the latter has been sufficiently filled and rolled to prevent its being displaced by so doing.

Where it is impossible to drive along the side of the macadam and spread the screenings directly from the wagon the contractor must dump sufficient screenings along the shoulder before the stone has been spread and rolled.

Rolling and Finishing Macadam.—In the preliminary rolling of both courses the large wheel of the roller is required to lap out on to the shoulder about 8 in., and after traveling the length of the portion to be rolled, the roller should cross over and return in the same manner on the other side. Crossing from one side to the other on unrolled portions is strongly opposed by the Department.

The rolling of the bottom course is continued until the stone are firmly locked together and do not weave to any extent ahead of the roller, or are not moved by the action of the feet in walking over the macadam.

Where the top-course stone must be hauled over the bottom course, the latter is well filled and rolled to sustain the travel.

No more water is used on the bottom course than is necessary in preparing it to sustain the travel of hauling the top course over it, without cutting or raveling. In most cases the desired result is obtained by dry rolling.

Where the subgrade is of clay, special care is taken not to soften it by the application of too much water, and in the final rolling the stone is not saturated but sprinkled just sufficiently to wet it without reaching the subgrade. It is then rolled several times and left until the next day, and this operation repeated from day to day until the desired result is obtained.

Under no circumstances is any driving allowed over the stone after the screenings have been spread, until the section has been given the first puddle. If the top-course stone is delivered faster than it can be rolled and puddled, it is spread and filled, but is not driven on until puddled and rolled.

It is seldom feasible to get any portion of the road thoroughly filled and puddled at the first operation. If, after the greater portion of the surface is filled with "grout," the road is left for several days to partially dry out, and then is again rolled and more screenings added, the final result can be obtained with less rolling and wetting than if attempted at one operation. Any depressions or hollows developed during rolling or puddling are filled with stone of the same size as the course being treated, thoroughly incorporated with the course before proceeding.

Sections of the road are opened to travel as soon as completed in dry weather, but in wet weather, when the travel brings on mud, the road is not opened in short sections, thus reducing to a minimum the number of places where mud is carried on to the road.

Guard-Rail.—In setting guard-rail the distance from the center of the road to the face of the posts is equal to one-half the width of the road-surfacing, plus two-thirds the width of the shoulder. Exceptions to this rule are made in setting short stretches of rail over culverts and in setting the end posts of all stretches. At culverts where only 24 ft. of guard-rail is used, the face of the middle panel is at the inside face of the parapet.

The end posts of all stretches of guard-rail are set at a distance of one-half the width of roadway from the center of the road and the entire top rail is a uniform distance above the center of the road. In setting the top rail a uniform side slope of 3 in. in 6 in. is used instead of allowing a 3-in. slope regardless of the width of the top of post. A guide for sawing the tops of the posts, similar to that used by carpenters in sawing miter joints, is the simplest method of securing this result.

Inspection.—There is constant inspection of all work and materials during the entire time the construction is in progress and the following rules are given especial attention:

"The thickness of each course of stone must be constantly watched by the engineer, or one of his assistants, during the entire time of spreading.

"The mixing of all mortar and concrete must be constantly watched to insure proper proportions and methods. In placing concrete it is very important to have the forms securely braced, so as to prevent any movement or misplacement. Masonry or concrete laid in warm weather should be protected from the sun by covering with burlap, grass or other satisfactory material, and kept damp until it has thoroughly set.

"Sand used for mortar or concrete must be carefully inspected, and if found to contain an injurious amount of foreign matter, it must be washed before using. Washing should be done by stirring the sand in running water.

"Paving must be watched to insure proper size and shape of stone and form of ditch. Care shall be taken to have the edge of the paving nearest the macadam slightly lower than the material of the shoulder, otherwise the paving will cause the water to follow along its edge, forming a ditch in the shoulder and tending to undermine the paving.

"Paving across drives or highways must be so formed that vehicles can pass over it without danger or inconvenience.

Cement.—No cement is used until it has been tested and accepted. Samples of cement are placed in paper bags, furnished by the Cement Testing Laboratory, Department of State Engineer, Albany, to which the samples are sent immediately after taking. The Laboratory is notified by standard notification cards when each package is forwarded, and a card is also enclosed in each package.

The contractor is informed that the cement he proposes to use on the work must be furnished with a view of being held for the 28-day test, as prescribed in the standard specifications, for only those showing very satisfactory tests are allowed to pass on the seven-day tests.

The contractor must provide a dry place, protected from the elements, for storing cement, and each shipment and each car lot must be kept separate, to enable the removal of any one lot in case of its rejection without causing the removal of a larger quantity.

Samples are taken by the engineer, or his representative, promptly on delivery, from every tenth barrel, or from the equivalent of the tenth barrel when packed in sacks. Each sample is taken to include cement from the surface to the center of the package sampled.

Each barrel or bag sampled is numbered consecutively throughout the progress of the work and its sample is marked in the same manner with the same number.

Results of tests are furnished in ten days from the seven-day test, and in thirty days from the 28-day test, but no cement is used until a notice of acceptance has been received from the Division Engineer. Any cement which has been rejected by the Department, because of failure to stand the required tests, is immediately removed at the expense of the contractor, under the general direction and in the presence of the engineer in charge.

Final Note Books.—For the purpose of making monthly and final estimates and for permanent record after the work is completed, all quantities, except as noted below, are recorded as the work progresses in standard note books furnished by the Division Engineer. Separate headings are made for each item of work, and under each heading is given the station or stations at or between which the item was used and the amount used in each case. If the item were used in a structure reference is made to the page in the book where the structure is shown, as described below. The following data must be given:

"Clearing and Grubbing: Give station, width of cutting and number of acres.

"Excavation or Embankment: Give the contract amount and show by stations any additions or deductions from this amount.

"Macadam: Give the contract amount and show by stations width, thickness and amount of any additions or deductions.

"Concrete: Give the station and nature of each structure, with amount in each, and refer to page where details may be found.

"Masonry: Same as concrete.

"Riprap, Telford Base, Paving and Cobble Gutter: Give station, width, thickness and amounts. If paving is at a culvert, refer to page where details may be found.

"Flagging and Expanded Metal: Give amounts by station and refer to page where details of structure may be found.

"Pipe: Give station, kind, size and length. If in a culvert, give page where details may be found.

"Steel, Cast Iron and Timber: Give stations, amounts and page where details of structure may be found.

"Guard, Bridge and Pipe-Rail: Give stations and side of road on which rail is used.

"Guide-Boards and Road-Signs: Give station and side of road where each post was erected and inscription on each."

Drawings to approximate scale of each structure are shown, with all dimensions and computations and a list of all items and amounts in each structure. When the work is completed, a general summary of all items is made in the back of the book and a final account compiled. This account shows the exact quantity of every item used in the construction of the road.

All final notes are entered neatly and legibly in ink in such a manner that they can be easily interpreted after the work is completed. The final note books are kept as a part of the permanent records of the office of each Division Engineer.

Acceptance.—After the completion of a road and before notifying the Deputy State Engineer of its completion, the Division Engineer has a profile of the center of the road made by a reliable employee not engaged upon the construction of the road. This profile is plotted upon the original working profile or upon a set of original blue prints in such a manner that it may readily be compared with the original profile and a written certification as to its correctness is placed on it by the engineer making it. In like manner an occasional cross-section is made at the places of the heavier cuts and fills. These data are presented for the inspection of the Deputy State Engineer when making his final inspection of the road.

Book Notes.

It has doubtless been a matter of surprise to a good many engineers that there has been no general book on the subject of clay and its products written in this country. While considerable information is available in the publications of the national and state geological surveys, it is not of a comprehensive character and these reports are often difficult to obtain. Accordingly Prof. Heinrich Ries has prepared a useful book in his "Clays; their Occurrence, Properties and Uses," which furnishes in compact form information that could only be obtained by prolonged search and correspondence before the book appeared. The author is particularly well qualified for his task, as he has investigated clays for a number of geological surveys and has made a special study of them in his laboratory at Cornell University. In the first chapter he describes the origin of clays and explains the various classifications of them that have been proposed. In doing this he carefully points out that a great deal must still be learned before our knowledge will be in a satisfactory condition, and in many parts of the country a great deal of investigation of clay beds may still be profitably carried on. In the second chapter the chemical properties of clay are discussed and the effect of various constituents is explained. The author rejects the common statement that all clays contain kaolinite, and points out that chemical analysis alone is unable to determine definitely what are the mineral constituents of clay. Attention is also called to the effect of certain minerals, such as titanic oxide, on the properties of clay of technical importance. The physical properties of clay are taken up in the third chapter, and it is interesting to observe that in respect to the most important of them, plasticity, the author takes a broader conception than that usually held, defining plasticity as the "property which many bodies possess of changing form under pressure, without rupturing, which form they retain when the pressure ceases, it being understood that the amount of pressure required and the degree of deformation possible will vary with the material. The available information concerning the causes of the physical properties is reviewed and criticized and the changes in the properties due to manufacturing processes are explained. The fourth chapter is an attempt to classify clays from a manufacturing point of view, something which ceramic specialists seem to regard as unadvisable although it is but natural that people looking into the industry for the first time or desirous of ascertaining if a given clay can be used for some purpose should urge the necessity of something of the sort. The chapter also contains a section explaining the general methods followed in manufacturing different classes of clay products. No attempt is made to go into details or to give directions for producing any given class of material, and it is not unlikely that in making general statements the author has occasionally not cared to indicate the exceptions to them. This portion of the book is a useful introduction to a more detailed knowledge of the manufacture of brick, terra cotta, pipe and pottery, when its limitations are borne in mind. The remainder of the volume is a description of the extent and nature of the clay deposits in different States. (New York, John Wiley & Sons, $5.00).

Letters to the Editor.

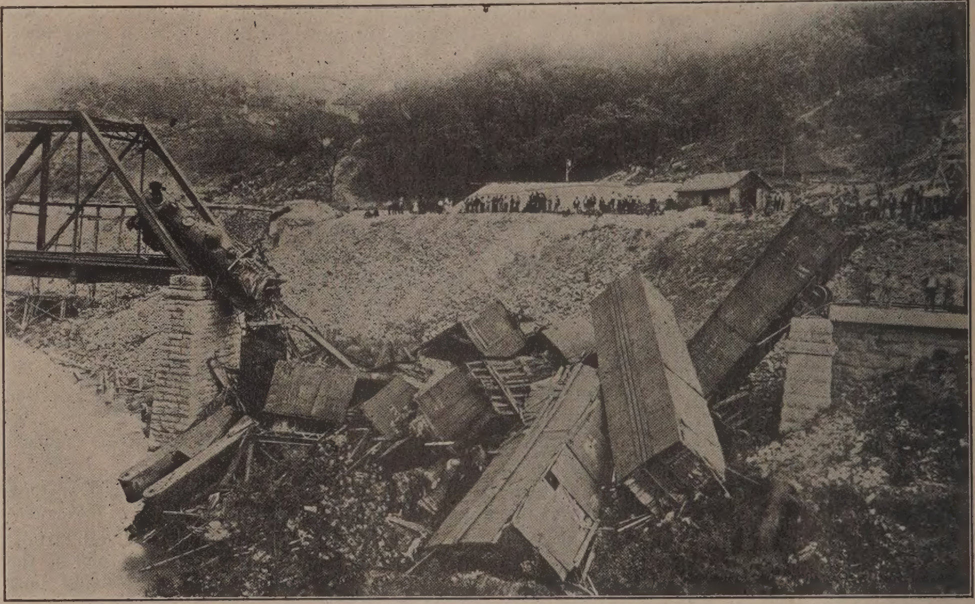
An Unusual Bridge Wreck.

Sir:—The accompanying picture may interest some of your readers, as it shows a wreck of an unusual nature on the Nashville, Chattanooga & St. Louis Ry. near Lookout Mountain. In the background of the picture is the new road that the Southern Ry. is building between Chattanooga and Stevenson, Ala., where it will connect with the present line of the Southern Ry. to Memphis. The tunnel through Lookout Mountain is just to the right of the picture. Just to the left of the picture is a high hill, the face of which had to be cut off in order to get the approach to the tunnel. This hill is nearly all earth excavation, and is being removed by steam shovels after being loosened by blasting. The bridge which was wrecked is a two-span structure across Chattanooga Creek.

About 3 o'clock on the afternoon of May 16, a blast went off in the earth excavation just mentioned. Whether this was premature or intentional I do not know; the man who set it off disappeared and has not been seen since. A mass of earth from the blast struck the bridge just as a freight train was entering it and wrecked it, dropping eleven cars through, as shown. This was a Southern Ry. train running to Chattanooga. Just to the river side of the picture the Nashville, Chattanooga & St. Louis Ry. was building a trestle across Chattanooga Creek to connect its line around Lookout Mt. with a freight yard which it is constructing on the Chattanooga side of the stream. Rubbish from the blast struck a pile driver on this work, killing a couple of men. In all seven lives were lost as a result of the blast, and a few houses on the hillside were damaged.

The tracks of the Nashville, Chattanooga & St. Louis Ry. at this place are also used by the Alabama Great Southern Ry. and by the Memphis division of the Southern Ry. All traffic was suspended, but passengers were transferred around the wreck. The trestle connecting with the freight yard was completed and the first train was run across it about 10 o'clock on the evening of May 18. The wreckage was then cleaned up and a temporary trestle put in, and the old bridge put in service again on May 23.

I do not know just why this blast did so much damage, but the most plausible explanation seems to be about as follows It is said that about 275 bbl. of powder were used in the blast. It is claimed that instead of the powder going to the bottom of the hole it caught about half way down and lodged there, with disastrous results when it was set off. C. E.



Wreck at Lookout Mountain Tunnel.

Uniform Contracts for Government Work.

Sir: By direction of the President, a committee has been appointed from the various executive departments in Washington to prepare uniform contracts for use by the Government. The committee consists of Mr. J. S. Wetmore, of the Supervising Architect's office, Pay Inspector J. S. Carpenter, of the Bureau of Supplies and Accounts of the Navy, Mr. Maurice Bien, of the Reclamation Service, and Messrs. W. W. Warwick and John Mason Brown of the office of the Comptroller of the Treasury. The committee is singularly well constituted to represent all phases of this question in Government work. The contracts with which Mr. Wetmore is directly concerned are contracts for architectural work. Mr. Bien is especially acquainted with engineering contracts, having had charge of the preparation of the forms of contract in use in the Reclamation Service, and Pay Inspector Carpenter in his official duties is necessarily concerned with the purchase of supplies and materials of every sort for the Naval service. The representatives of the Comptroller's office are both of them lawyers of ability, who have dealt especially with the construction of the various provisions of public contracts now in use. Mr. Warwick is chief law clerk in the Comptroller's office and Mr. Brown is the author of a brief but valuable work on the law of contracts, which has been very extensively purchased by the government.

They are to take into consideration the forms of government contracts for all purposes. These may roughly be divided into two classes, contracts for the purchase of supplies and material, including all classes of machinery, and contracts for the construction of the numerous public works in which the United States is engaged, including river and harbor improvements, irrigation projects, public buildings of all classes and wharves and docks.

It is found upon investigation that the forms used in the different departments vary widely, having been modified from time to time by the heads of different departments as conditions arose. The attention of government officers has been of late directed to the fact that the general use in government contracts of provisions vesting a very wide discretion in the government engineer or superintendent and provisions bearing with special severity upon the contractor, while nominally to the advantage of the government, have operated greatly to its disadvantage.

Contractors of wide experience who have large demands upon them for their services prefer to work under contracts which are drawn with a due regard to fairness upon each side. When specifications disclose that the contractor is placed at the mercy of the other party and is subject to the exercise of an uncontrolled discretion, he is not inclined to bid under such specifications. The government has failed to receive bids from many contractors of high reputation because they did not like the conditions under which the work is to be done. Then, too, a contractor who understands the conditions of government work under these severe restrictions, finds it necessary to add an emergency percentage for the risk which these require of him. Consequently, the bids upon government work, when made by contractors of experience in it, have often been considerably higher than their bids upon private work of the same kind. It is common to hear successful contractors say, either that they will not take Government work at all or that if they do take it, they will take it only upon their own terms. The result of this is to the disadvantage of the Government, both in paying higher prices and in losing the benefit of the work of many of the best-equipped contractors in the country.

Much of this difficulty can be avoided by the adoption of a form of contract which will be satisfactory both to contractors and to the government. It is understood that the committee will take ample time for deliberation and discussion on this subject, in the hope of creating better conditions so far as the fault lies in the present forms of contracts. The Committee of the American Public Works Association appointed to prepart a uniform contract for engineering work, of which Mr. G. O. Tenney, of Richmond, is chairman, has placed itself in communication with this official committee and will present to it the result of its labors in the draft of a uniform contract.

Yours truly, Observer.

Hydraulic Rams driven by artesian wells are used in the lower Potomac valley and along Chesapeake Bay. The well pressure is ample to furnish supplies at the shore but does not serve the higher banks, so the artesian flow is used to run rams for the high service.